IN THE UNITED STATES DISTRICT COURT
FOR THE NORTHERN DISTRICT OF OKLAHOMA

STATE OF OKLAHOMA, EX REL. W.A. DREW EDMONDSON, in his capacity as ATTORNEY GENERAL OF THE STATE OF OKLAHOMA AND OKLAHOMA SECRETARY OF THE ENVIRONMENT C. MILES TOLBERT, in his capacity as the TRUSTEE FOR THE NATURAL RESOURCES FOR THE STATE OF OKLAHOMA,

Plaintiffs,

TYSON FOODS, INC., TYSON POULTRY, INC., TYSON CHICKEN, INC., COBB-VANTRESS, INC., CAL-MAINE FARMS, INC., CARBILL, INC., CARGILL TURKEY PRODUCTION, LLC, GEORGE'S, INC. GEORGE'S FARMS, INC., PETERSON FARMS, INC., SIMMONS FOODS, INC., and WILLOW BROOK FOODS, INC.,

Defendants.

Case No. 05-CV-00329 GKF-SAJ

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U.S. DISTRICT COURT

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	)	
Defendants.	)	

MOTION OF GEORGE R. STUBBLEFIELD ADAIR COUNTY REPRESENTATIVE OKLAHOMA SCENIC RIVERS COMMISSION STEVEN B. RANDALL DELAWARE COUNTY REPRESENTATIVE OKLAHOMA SCENIC RIVERS COMMISSION FOR PERMISSION TO FILE BRIEF AS AMICUS CURIAE IN OPPOSITION TO THE PLAINTIFFS' MOTION <u>FOR PRELIMINARY INJUNCTION AND BRIEF IN SUPPORT THEREOF</u>

George R. Stubblefield, representing landowners – stakeholders- in Adair County, Oklahoma, and Steven B. Randall, representing landowners – stakeholders – in Delaware County asks leave to file a brief in response to the Plaintiff's Motion for Preliminary Injunction.

The landowners – stakeholders – of Adair and Delaware Counties in Oklahoma – who are each represented with one elected seat on the 12-member Oklahoma Scenic Rivers Commission – have no representation before the Court as it considers the State's pleading for injunctive relief.

This brief is offered to provide a voice on behalf of those stakeholders who are not parties before the Court and to provide data and context for the Court as it considers the State's request for injunctive relief.

Counsel for defendants have stated that they do not object to this motion. No assertion is made to the Court whether counsel for plaintiffs object.

In support of this motion, Commissioners Stubblefield and Randall would show the Court as follows:

1. An analysis of the size and scope of poultry litter produced in the Illinois River watershed based on real-time data available to the general public.

2. An analysis of the Plaintiff's contention that poultry litter is a discarded material which constitutes a solid waste, vs. real time practices of utilizing poultry litter as fertilizer both inside and outside the Illinois River watershed.

3. An analysis of the Plaintiff's assertions regarding the imminent health threat posed by bacteria present in poultry litter, and analysis of Oklahoma Department of Health records.

Commissioners Stubblefield and Randall believe the issues which they wish to present as an Amicus Curiae in this matter will be of substantial assistance to the court, providing perspective, context and information that will not otherwise be brought to the Court's attention.

For the reasons set forth above, Commissioners George R. Stubblefield and Steven B. Randall respectfully request that the Court grant leave to file a brief in this matter as Amicus Curiae, and to set the time for its filing its Brief consistent with the briefing schedule for the defendants.

II.

PRELIMINARY STATEMENT

The State of Oklahoma (ex rel. W.A. Drew Edmondson, in his capacity as Attorney General of the State of Oklahoma and Oklahoma Secretary of the Environment C. Miles Tolbert, in his capacity as the Trustee For The Natural Resources Of The State Of Oklahoma) is asking the Court to prohibit the surface land application of poultry litter in the Illinois River watershed in both Oklahoma and Arkansas.

The Court is being asked to enjoin two groups of individuals not named as defendants. The first group is made up of contract growers who land apply poultry litter on lands they own in the Illinois River watershed.

The second group of individuals is made up of farmers located in the Illinois River watershed not involved in poultry production, but who purchase poultry litter from contract growers, and who then fertilize lands they own with poultry litter.

To support the request for its preliminary injunction, W.A. Drew Edmondson and C, Miles Tolbert allege 347,000 tons of poultry litter are produced each year in the Illinois River watershed, that Oklahoma Department Of Health Records suggest a direct causation between fecal bacteria present in poultry litter and rates of incidence for certain diseases, and that poultry litter should be defined a "solid" waste because poultry litter should be considered "discarded" and the use of poultry litter as a fertilizer should be viewed by the Court as a "waste disposal practice."

III.

FACTUAL PREDICATE.

A. The Illinois River watershed includes portions of Washington and Benton Counties in northwest Arkansas and portions of Delaware, Cherokee, Adair and Sequoyah Counties in Oklahoma. The area is a thriving mix of small rural communities, suburban sprawl and urban centers.

B. Census estimates for 2005 put the population of those counties included in the IRW at 513,968. By way of comparison, Tulsa County in Oklahoma had an estimated population in 2005 of 572,059. (Exhibit No. 1)[A]

While the topography of the lands adjacent to the Illinois River in Oklahoma create an illusion of wilderness area for visitors, in reality Oklahoma's most-publicized scenic stream winds its way through the shadows of a growing suburban and semi-metropolitan zone.

C. In August of 2006 The Office of The Oklahoma Secretary Of The Environment provided a document to the Oklahoma Scenic Rivers Commission Titled ***"Fact Sheet: Poultry Litter And The Illinois River"*** (Exhibit No. 2)[B]. In that document The Secretary of The Environment's office asserted **542,948 tons of poultry litter are produced each year** from **3,057** poultry houses in the Illinois River watershed.

[A] 1 Annual Estimates of the Population For Counties of Oklahoma, Arkansas: April 1, 2000 to July 1, 2005. POPULATION DIVISION, U.S. Census Bureau, March 16, 2006

[B] FACT SHEET: Poultry Litter And The Illinois River Watershed State Of Oklahoma Office of the Secretary of the Environment, Sept. 2006

During an October 2006 speaking engagement, when questioned regarding the accuracy of the numbers released through the office of the Secretary of the Environment, W.A. Drew Edmondson is quoted as follows in the *Norman Transcript*: (Exhibit No. 3)[C]

> ***"We sent investigators in the field and visually counted the number of houses...and that count was 3,057. I'm not going to go into court without the proper data. That's why we sent people to count the houses."***

13 months after the Secretary Of The Environment asserted to the Oklahoma Scenic Rivers Commission that the poultry industry produces **542,948** tons of litter from 3,057 houses located in the Illinois River watershed each year, the State now asserts in its request for injunctive relief that **347,000** tons of poultry litter are produced annually in the Illinois River watershed each year – 36% less than claimed in September 2006.

Accurate numbers with regard to how many operating poultry houses are located in the Illinois River watershed are crucial when calculating the volume of poultry litter produced in the Illinois River watershed. While poultry house estimates can be valuable to the Court *when substantive data is unavailable*, with regard to the Illinois River watershed, estimates can be substituted with substantive data available to the general public.

The Oklahoma Department of Agriculture maintains Poultry Statistical Data information for the Oklahoma side of the Illinois River watershed. According to a Department memorandum, as of

[C] Transcript, October 25, 2006

November 1, 2007 there were 185 registered poultry houses on the Oklahoma side of the Illinois River watershed. (Exhibit No. 4)[D]

The Arkansas Natural Resources Commission maintains Poultry Statistical Data for the Arkansas side of the Illinois River watershed. A Jan. 23, 2008 Commission memorandum noted that during the 2007 registration period there were approximately 1410 poultry houses registered in the Illinois River watershed in Arkansas. (Exhibit No. 5)[E]

The total number of active poultry houses indicated from the information referenced above, <u>information available to the general public,</u> stands as of this writing at: 1,595.

The volume of poultry litter produced in the watershed is determined by a simple formula – total number of houses x tons of litter per house = total volume of poultry litter.

There are different estimates used to determine how much litter is produced by a poultry house each year. The Eucha-Spavinaw Watershed Management Team, created by the Court as a result of *Tulsa v Tyson, et al* uses 120 tons of poultry litter annually per house in determining the total volume of litter in the Eucha-Spavinaw watershed (Exhibit No. 6)[F].

A University of Arkansas Division of Agriculture documented study reported litter tonnage between 92 and 120 tons produced each year. (Exhibit No.7)[G]

[D] Oklahoma Department of Agriculture, Food and Forestry Agricultural Environmental Management Services, January 7, 2008 Memorandum

[E] Arkansas Department of Agriculture January 23, 2008 Memorandum

[F] Eucha-Spavinaw Watershed Management Team Memorandum, August 31, 2006

[G] T. Tabler, "How Much Litter Do Broilers Produce?", University of Arkansas Cooperative Extension Service, Fall 2000.pp 6-7.

Using the Eucha-Spavinaw Watershed Management Team 120 tons of litter per house, the total poultry litter produced each year in the Illinois River watershed would be 191,400 tons.

The use of 120 tons of poultry litter per year in calculating the total volume of poultry litter results in totals roughly 40% less than those referenced in the state's request for injunctive relief, and roughly 65% less than asserted by the office of the Secretary of the Environment in September of 2006.

BMPS, Inc., one entity created as a result of the Statement of Joint Principles And Actions (Exhibit No. 8)[H] between the states of Oklahoma and Arkansas in December 2003 to administer cooperative and joint programs to haul poultry litter out of the Illinois River and Eucha-Spavinaw watersheds, reported to the Oklahoma Scenic Rivers Commission in August of 2007 it had tracked the hauling of 74,000 tons of poultry litter out of the Illinois River watershed in the 12 months preceding (Exhibit No. 9)[I].

Private market demand for poultry litter as a fertilizer across the state of Oklahoma has surged with rising prices for commercial fertilizers. Oklahoma State University has created a website titled "Oklahoma Litter Market' www.oklittermarket.org . A visit to the website Jan. 18, 2008 showed a waiting list of 185 buyers seeking to purchase 124,000 tons of poultry litter to be used as fertilizer on lands outside the Illinois River watershed (Exhibit No. 10)[J]. Farmers in the Illinois River

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[H] Statement Of Joint Principles And Actions, December 18, 2003

[I] Memorandum to Oklahoma Scenic Rivers Commission, October 22, 2007

[J] Oklahoma Litter Market website, produced by Oklahoma State University Water Quality Extension Program, developed and funded by Oklahoma Conservation Commission from a U.S. EPA 319h grant.

watershed who wish to utilize poultry litter as fertilizer are facing competition for available poultry litter.

D. The study of bacteria present in animal manures in general is well documented.(Exhibit No. 11)[K] Published works which detail studies of bacteria present specifically in poultry litter are also numerous. In some instances, studies such as Survey of Pathogens In Poultry Litter In The United States (Exhibit No. 12)[L] are produced by the poultry industry for researchers, veterinarians, production managers and quality assurance personnel.

The State references Oklahoma Department of Health (ODH) infectious disease records as a reasonable basis for concluding "exposure to fecal bacteria from poultry waste that has run off and seeped into the surface water and groundwater of the State in the Illinois River watershed presents an imminent and substantial endangerment to human health." The State supports this conclusion with selective reference to Oklahoma Department of Health records. It is appropriate to examine ODH records in greater detail.

The Oklahoma Department of Health publishes "Fact Sheets" for the education of the general public with regard to each of the infectious diseases referenced in the State's request for injunctive relief. The fact sheets are available on the Oklahoma Department Of Health Website – www.health.state.ok.us - a review of the fact sheets referencing the specific infectious diseases the State mentions reveals the following statements regarding causation:

[K] Saied Mostaghimi, H.E. and Elizabeth F. Alpin, Michelle Soupir, Bacteria Release and Transport from Livestock Manure Applied To Pastureland, July 27, 2003

[L] Mac Terzich, Melody J. Pope, Tim E. Cherry, Jessie Hollinger, Survey of Pathogens in Poultry Litter in the United States, January 2000.

> Cryptosporidiosis: "The parasite is found in every region of the United States and throughout the world...the most important animal source of Cryptosporidium in the United States is cattle." (Exhibit No. 13)[M]

NOTE: There were no cases of Cryptosporidiosis reported in the Illinois River watershed for 2005 and only 2 cases for Delaware County in 2006 in the Illinois River watershed. Eleven (11) Oklahoma counties reported cases in 2005, and Fourteen (14) counties reported cases in 2006. (Exhibit No. 14 and No. 15)[N]

> Campylobacter: "Infection with Campylobacter mainly occurs by eating raw or undercooked chicken or pork, or contaminated food or raw milk. Illness may also be caused by handling raw poultry or pork and then not washing the hands...most infections come from eating food contaminated with the bacteria. (Exhibit No. 16)[O]

NOTE: The statewide incidence rate per 100,000 in Oklahoma for Campylobacter in 2005 was 15.77. Thirty Two (32) Oklahoma counties - including Oklahoma County- exceeded the statewide incidence rate. The highest incidence rate was in Tilman County, 96.91 – Harper County was 56.15 – Alfalfa County was 49.14 – Pawnee County was 48.16. In the Illinois River watershed, only Adair County exceeded the statewide incidence rate, at 47.53. For 2006 the statewide incidence

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[M] Public Health Fact Sheet CRPTOSPORIDIOSIS, Oklahoma Department of Health, http://www.health.ok.gov/program/cdd/

[N] 2005 Annual Summary of Infectious Diseases, Oklahoma Department of Health and 2006 Annual Summary of Infectious Diseases, Oklahoma Department of Health.

[O] Public Health Fact Sheet CAMPYLOBACTER, Oklahoma Department of Health, http://www.health.ok.gov/program/cdd/

rate per 100,000 was 11.77. Thirty-One (31) counties exceeded that incidence rate. The highest incidence rate was in Greer County with 49.50 – Okmulgee County followed with 40.32 - all counties in the Illinois River watershed in 2006 exceeded the statewide incidence rate, with an average incidence rate of 19.86. (Exhibit No. 14 and No. 15)

> Salmonellosis: "Most infections are caused by eating food contaminated with Salmonella. The contamination is from the feces of infected humans or animals. Contaminated foods are often of animal origin. These include raw or undercooked eggs and egg products, raw or unpasteurized milk and milk products, poultry and beef..." (Exhibit No. 17)[P]

NOTE: The statewide incidence rate per 100,000 in Oklahoma for Salmonellosis in 2005 was 12.98 and 17.53 in 2006.. Thirty-three (33) of Oklahoma's 77 Counties, including Oklahoma County, exceeded the statewide incidence rate for Salmonellosis in 2005. Adair County had an incident rate of 42.78 – the only county in the Illinois River watershed which exceeded the statewide incidence rate.

In 2006 Thirty-Eight (38) counties reported rates higher than the statewide incidence rate. All four counties in the Illinois River watershed showed incidence rates slightly higher than the statewide incidence rate – an average incidence rate of 19.26. Roger Mills County had an incidence rate of 116.41; Pushmataha County had an incidence rate of 77.14; Coal County had an incidence rate of 49.74; Stephens County and Jefferson County had an incidence rate of 44.00; Garvin County had an incident rate of 40.43. (Exhibit No. 14 and No. 15)

[P] Public Health Fact Sheet SALMONELLOSIS, Oklahoma Department of Health, http://www. health.ok.gov/program/cdd/

> Giardiasis: "...Is a common cause of diarrhea in the U.S...Giardia is found in infected people (who may or may not be ill) and in wild and domestic animals. Giardia is also found in lakes and streams that were contaminated with feces (stool) from infected humans or animals." (Exhibit No. 18)[Q]

NOTE: The statewide incidence rate per 100,000 in Oklahoma for Giardiasis in 2005 was 5.70. Twenty-Six (26) of Oklahoma's Seventy-Seven (77) Counties exceeded the statewide incidence rate for Giardiasis. Not one of these counties was located in the Illinois River watershed. In 2006 the statewide incidence rate was 4.81. Twenty-Eight (28) counties exceeded the statewide incidence rate, including three counties in the Illinois River watershed. Cherokee County in the watershed had an incidence rate lower than the statewide rate. (Exhibit No. 14 and No. 15)

> E-Coli: "Failure to wash hands after contact with animals...is a well-known risk factor for EHEC infection." (Exhibit No. 19)[R]

NOTE: The statewide incidence rate per 100,000 in Oklahoma for E-Coli in 2005 was 1.1. Thirteen (13) of Oklahoma's 77 Counties exceeded the statewide incidence rate for E-Coli. The highest incidence was reported in Pittsburg County, followed by Blaine County, then Rogers County, Beckham County and Adair County, which was the only county in the Illinois River watershed to exceed the statewide incidence rate. The 2006 statewide incident rate was 1.28 – Twenty-Two (22) counties in Oklahoma exceeded the statewide incident rate. In the Illinois River Watershed,

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[Q] Public Health Fact Sheet GIARDIASIS, Oklahoma Department of Health, http://www.health.ok.gov/program/cdd/

[R] Public Health Fact Sheet ENTEROHEMORRHAGIC ESCHERICHIA COLI INFECTION Fact Sheet, Oklahoma Department of Health, http://www.health.ok.gov/program/cdd

Cherokee County was the only county to report an incident, which made their incident rate 2.35. Exhibit No. 14 and No. 15)

Data reported by ODH suggests periodic decreases and increases in the incidence of infectious diseases across the state from county to county, year to year. Even urban counties such as Oklahoma County report some infectious disease rates exceeding statewide incident rates and exceeding incident rates in the Illinois River watershed for diseases specifically mentioned by the State within the 2005-2006 data reviewed.

Oklahoma Water Resources Board head of water quality, Derek Smithee, reported to the Oklahoma Scenic Rivers Commission during its June 2006 meeting specifically with regard to the issue of bacteria in Oklahoma waterways. OSRC minutes for June 2006 include the following:

> **"Administrator Fite briefly turned over the floor to Derek Smithee...He said the Oklahoma Water Resources Board is focusing their attention on the bacteria issue and how to address** its many facets. **He stressed that although there is an elevated level of bacteria in Oklahoma streams and lakes,** more people get sick from community swimming pools than from Oklahoma streams and lakes." (Exhibit No. 20)[S]

The highest bacteria levels in the Illinois River watershed are recorded during high water – storm events. On its website – www.oklahomascenicrivers.net - the Oklahoma Scenic Rivers Commission and the Illinois River Association of commercial float operators strongly discourage recreational floating when the Illinois River when water levels are above 9 ft. six inches, which effectively precludes recreational contact during periods of high water.

[S] Minutes of Oklahoma Scenic Rivers Commission June 20, 2006 Regular Meeting, p.7.

The Blue Thumb Volunteer monitoring program routinely monitors streams across the state of Oklahoma for chemical and bacteria. Bacteria sampling from streams located in urban areas, such as Polecat Creek and Mooser Creek in Tulsa County and even Tahlequah Creek (Town Branch) which runs through the city of Tahlequah have shown e-coli levels "very high" and "higher than expected" (Exhibit No. 21)[T]

In its request for injunctive relief, The State requests the Court define poultry litter as a solid waste within the meaning of RCRA based on 42 U.S.C. 6903(27) which provides:

> The term "solid waste" means any garage , refuse, sludge from a waste treatment plant, water supply treatment plant, or air pollution control facility **and other discarded material, including solid, liquid, semisolid, or containing gaseous material resulting from industrial, commercial, mining, and agricultural operations...**

E. The State asserts **poultry litter is discarded by contract growers** in the Illinois River watershed, and that **the use of poultry litter as a fertilizer is a waste disposal practice.**

Webster's Online Dictionary defines discarded as 1. Thrown away; "wearing someone's cast-off clothes". 2. Disposed of as useless; "waste paper". (Exhibit No. 22)[U]

Webster's Online Dictionary defines waste as 1. (Adjective) Disposed of as useless. (Noun) Any materials unused and rejected as worthless or unwanted. (Exhibit No. 23)[V]

[T] Blue Thumb Program, Data Interpretation: Tahlequah Creek, Polecat Creek, Mooser Creek, Oklahoma Conservation Commission, http://www.ok.gov/okcc

[U] Webster's Online Dictionary http://www.websters-online-dictionary.org/definition/Discarded

[V] Webster's Online Dictionary http://www.websters-online-dictionary.org/definition/Waste

Contrary to Plaintiff's assertions, poultry litter is neither "thrown away" or "disposed of as useless". The **value of poultry litter** is well-documented and asserted by numerous entities across the United States. The Natural Resources Conservation Services of the United States Department of Agriculture – Oklahoma and Mississippi Information Sheet describes poultry litter as "a valuable resource that can provide significant amounts of natural fertilizer…the value of poultry litter should be based on a cost comparison with commercial fertilizer…"(Exhibit No. 24)[W]

The North Carolina Cooperative Extension Service asserts "Poultry litter is an excellent source of nutrients and can be incorporated into most fertilizer programs." (Exhibit No. 25)[X]

The Oklahoma Cooperative Extension Fact Sheet "Using Poultry Litter As A Fertilizer" asserts:

> **"Poultry litter is an excellent low cost fertilizer if used properly. Land application of litter returns nutrients and organic matter to the soil, building soil fertility and quality**…"(Exhibit No. 26)[Y]

Plaintiffs remain silent on the State of Oklahoma's own published and distributed documentation supporting the inherent value of poultry litter specifically as a fertilizer. In asserting the use of poultry litter as a fertilizer is a waste disposal practice in the Illinois River watershed, the request for injunctive relief is also silent on the work of the legislative and regulatory arms of the

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[W] Natural Resources Conservation Service Oklahoma and Mississippi Information Sheet Regarding Poultry Litter, January 2006 (Oklahoma) and October 2006 (Mississippi).

[X] North Carolina Cooperative Extension Service "Soil Facts: Poultry Manure As A Fertilizer Source" , May 1993 Revised.

[Y] Oklahoma Cooperative Extension Service, "Using Poultry Litter As Fertilizer" PSS-2246.

State, which through statute and regulation strictly govern the use of poultry litter as a fertilizer in The Illinois River watershed and other nutrient-threatened watersheds. (Exhibit No. 27)[z]

IV.

CONCLUSION

Plaintiffs' assertions regarding the volume of poultry litter produced in the Illinois River watershed are not supported by publicly available data regarding the number of poultry houses in the Illinois River watershed.

Plaintiffs' Oklahoma Department of Health records are selectively referenced – a reasonable analysis of ODH records do not support causation contentions or support Plaintiff's assertion of "imminent danger".

The Court is asked to apply a tortuous definition to "discarded" in order to define poultry litter a "solid waste" as defined by CERCLA. In asking the court to apply this tortuous definition, Plaintiffs ignore the State's own assertions regarding the value of poultry litter as a fertilizer, as well as statutes and regulations governing the use of poultry litter.

The Court is asked to ignore any potential financial burden or hardship that granting its petition would levy on landowners and contract growers in the Illinois River watershed. The primary impact would fall on contract growers who currently use poultry litter on their own lands in a regulated and lawful manner, and on landowners within the watershed who purchase poultry litter and again apply that litter in a regulated and lawful manner.

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[z] Oklahoma Poultry Feeding Operations Poultry Waste Applicator, Poultry Waste Transfer Regulations and Acts, published by Oklahoma Department of Agriculture, Food and Forestry

F. The public interest is best served by the Court denying Plaintiffs' request for injunctive relief. It is inconceivable that a ruling by the Court declaring poultry litter a solid waste would not be interpreted broadly to include all animal manure. Such an interpretation would negatively impact the use of animal manure as fertilizer across a broad spectrum of agriculture and residential uses. Such a ruling would have the potential to devastate programs specifically designed to promote the transfer of animal manures from nutrient-threatened watersheds - a well-recognized and promoted remedy. The growth and future expansion of those programs to include other forms of animal manure in nutrient-threatened watersheds is threatened by Plaintiffs' request that poultry litter be labeled a "solid waste".

Plaintiffs may well argue these programs in part constitute taxpayer contributions that should be borne by family farmers. Federal and state farm subsidy programs which support the certainty and availability of affordable food products in the United States have a long and well-documented history. The availability of federal and state grants and tax incentive programs with regard to manure transfer programs should be viewed by the Court as a logical part of that farm subsidy philosophy.,

The Court should deny Plaintiff's request for injunctive relief.

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CERTIFICATE OF MAILING

We, George R. Stubblefield and Steven B. Randall do hereby certify that on this 21st day of February, 2008, I mailed a true and correct copy of the above and foregoing to the following with proper postage thereon, fully prepaid:

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Table 1. Annual Estimates of the Population for Counties of Oklahoma: April 1, 2000 to July 1, 2005

Geographic Area	Population estimates						April 1, 2000	
	July 1, 2005	July 1, 2004	July 1, 2003	July 1, 2002	July 1, 2001	July 1, 2000	Estimates base	Census
Oklahoma	**3,547,884**	**3,523,546**	**3,504,917**	**3,487,076**	**3,465,778**	**3,454,321**	**3,450,652**	**3,450,654**
Adair County	21,988	21,751	21,595	21,347	21,233	21,078	21,038	21,038
Alfalfa County	5,725	5,842	5,882	5,953	6,000	6,091	6,105	6,105
Atoka County	14,456	14,304	14,150	14,000	13,889	13,849	13,879	13,879
Beaver County	5,379	5,464	5,537	5,561	5,647	5,788	5,857	5,857
Beckham County	18,880	18,388	19,330	19,959	19,858	19,755	19,799	19,799
Blaine County	12,859	12,877	11,284	11,678	12,077	11,965	11,976	11,976
Bryan County	37,815	37,623	37,150	36,948	36,657	36,626	36,534	36,534
Caddo County	30,229	30,229	30,098	29,996	30,027	30,114	30,150	30,150
Canadian County	98,701	95,581	92,914	91,062	89,678	88,212	87,697	87,697
Carter County	47,125	46,906	46,488	46,090	45,669	45,597	45,621	45,621
Cherokee County	44,671	44,159	43,777	43,400	42,882	42,675	42,521	42,521
Choctaw County	15,297	15,387	15,314	15,374	15,201	15,350	15,342	15,342
Cimarron County	2,833	2,907	2,966	3,018	3,062	3,149	3,148	3,148
Cleveland County	224,898	221,124	218,713	215,055	212,156	208,310	208,016	208,016
Coal County	5,743	5,898	5,963	5,983	6,054	6,009	6,031	6,031
Comanche County	112,429	113,058	110,193	111,717	112,131	114,624	114,996	114,996
Cotton County	6,589	6,531	6,567	6,463	6,520	6,648	6,614	6,614
Craig County	15,078	14,932	14,854	14,758	14,812	14,955	14,950	14,950
Creek County	68,708	68,647	68,758	68,665	68,134	67,566	67,369	67,367
Custer County	25,208	25,136	25,220	25,086	25,617	26,061	26,142	26,142
Delaware County	39,146	39,053	38,599	37,980	37,740	37,201	37,077	37,077
Dewey County	4,568	4,653	4,575	4,596	4,649	4,714	4,743	4,743
Ellis County	3,963	3,978	3,970	4,006	3,939	4,053	4,075	4,075
Garfield County	56,958	57,325	57,226	57,212	57,307	57,683	57,813	57,813
Garvin County	27,228	27,107	27,207	27,240	27,086	27,278	27,210	27,210
Grady County	49,369	48,265	47,351	46,812	45,876	45,597	45,516	45,516
Grant County	4,779	4,795	4,968	5,031	5,074	5,130	5,144	5,144
Greer County	5,901	5,895	5,865	5,942	5,862	6,028	6,061	6,061
Harmon County	3,030	3,000	3,061	3,117	3,180	3,282	3,283	3,283
Harper County	3,313	3,383	3,385	3,455	3,439	3,544	3,562	3,562
Haskell County	12,183	12,092	12,041	11,780	11,906	11,824	11,792	11,792
Hughes County	13,835	13,957	13,943	14,026	13,902	14,139	14,154	14,154
Jackson County	26,518	27,100	27,234	27,380	27,929	28,256	28,439	28,439
Jefferson County	6,461	6,483	6,532	6,531	6,611	6,784	6,818	6,818

Exhibit

" 1 "

Table 1. Annual Estimates of the Population for Counties of Oklahoma: April 1, 2000 to July 1, 2005

Johnston County	10,259	10,378	10,489	10,435	10,414	10,513	10,513	10,513
Kay County	46,480	46,802	47,267	47,643	47,501	47,943	48,080	48,080
Kingfisher County	14,302	14,138	14,074	13,926	13,900	13,900	13,926	13,926
Kiowa County	9,848	9,815	9,957	9,980	10,074	10,206	10,227	10,227
Latimer County	10,635	10,626	10,542	10,560	10,586	10,679	10,692	10,692
Le Flore County	49,528	49,155	48,862	48,593	48,216	48,164	48,111	48,109
Lincoln County	32,311	32,294	32,225	32,257	32,134	32,146	32,080	32,080
Logan County	36,894	36,514	35,596	34,870	34,600	33,953	33,924	33,924
Love County	9,126	9,080	8,960	8,875	8,784	8,826	8,831	8,831
McClain County	30,096	29,114	28,644	28,057	27,869	27,851	27,740	27,740
McCurtain County	33,992	33,927	34,064	34,136	34,170	34,409	34,402	34,402
McIntosh County	19,965	19,902	19,832	19,716	19,584	19,480	19,456	19,456
Major County	7,364	7,369	7,405	7,536	7,541	7,539	7,545	7,545
Marshall County	14,461	13,952	13,683	13,593	13,344	13,173	13,184	13,184
Mayes County	39,471	39,186	38,940	38,749	38,512	38,444	38,369	38,369
Murray County	12,880	12,713	12,686	12,641	12,699	12,617	12,623	12,623
Muskogee County	70,607	70,478	70,399	69,912	69,740	69,461	69,451	69,451
Noble County	11,211	11,256	11,270	11,300	11,406	11,379	11,411	11,411
Nowata County	10,864	10,719	10,881	10,652	10,615	10,591	10,569	10,569
Okfuskee County	11,434	11,615	11,673	11,640	11,700	11,802	11,814	11,814
Oklahoma County	684,543	679,498	676,416	671,409	664,687	661,699	660,448	660,448
Okmulgee County	39,732	39,764	39,794	39,713	39,676	39,649	39,685	39,685
Osage County	45,416	45,073	45,156	45,177	45,055	44,555	44,434	44,437
Ottawa County	32,866	32,818	32,730	32,875	33,219	33,253	33,194	33,194
Pawnee County	16,860	16,793	16,875	16,833	16,859	16,699	16,612	16,612
Payne County	69,151	69,389	69,707	69,024	69,159	68,159	68,190	68,190
Pittsburg County	44,641	44,239	44,081	44,128	43,637	43,969	43,953	43,953
Pontotoc County	35,346	35,059	34,986	34,851	34,818	35,143	35,143	35,143
Pottawatomie County	68,272	67,719	67,798	66,759	66,305	65,705	65,521	65,521
Pushmataha County	11,693	11,730	11,689	11,717	11,726	11,657	11,667	11,667
Roger Mills County	3,311	3,254	3,196	3,214	3,338	3,423	3,436	3,436
Rogers County	80,757	79,032	77,264	75,222	73,274	71,371	70,638	70,641
Seminole County	24,770	24,707	24,541	24,560	24,729	24,886	24,894	24,894
Sequoyah County	40,868	40,553	39,970	39,649	39,295	39,066	38,972	38,972
Stephens County	42,946	42,773	42,523	42,602	42,751	43,079	43,182	43,182
Texas County	20,112	20,236	19,914	20,045	20,132	20,181	20,105	20,107
Tillman County	8,513	8,724	8,898	8,921	9,259	9,255	9,287	9,287
Tulsa County	572,059	568,611	569,813	569,780	566,284	563,832	563,301	563,299

Table 1: Annual Estimates of the Population for Counties of Oklahoma: April 1, 2000 to July 1, 2005								
Wagoner County	64,183	62,793	61,718	60,506	58,895	57,738	57,491	57,491
Washington County	49,149	49,066	49,087	49,174	48,974	48,996	48,996	48,996
Washita County	11,471	11,443	11,350	11,360	11,416	11,510	11,508	11,508
Woods County	8,546	8,507	8,650	8,774	8,808	9,046	9,089	9,089
Woodward County	19,088	18,902	18,602	18,491	18,389	18,439	18,486	18,486

Note: The April 1, 2000 Population Estimates base reflects changes to the Census 2000 population from the Count Question Resolution program and geographic program revisions. Dash (-) represents zero or rounds to zero. (X) Not applicable

Suggested Citation:

Table 1: Annual Estimates of the Population for Counties of Oklahoma: April 1, 2000 to July 1, 2005 (CO-EST2005-01-40)

Source: Population Division, U.S. Census Bureau

Release Date: March 16, 2006

Table 1. Annual Estimates of the Population for Counties of Arkansas: April 1, 2000 to July 1, 2005

Geographic Area	Population estimates						April 1, 2000	
	July 1, 2005	July 1, 2004	July 1, 2003	July 1, 2002	July 1, 2001	July 1, 2000	Estimates base	Census
Arkansas	**2,779,154**	**2,750,000**	**2,726,166**	**2,706,606**	**2,691,581**	**2,678,511**	**2,673,398**	**2,673,400**
Arkansas County	20,073	20,115	20,111	20,376	20,575	20,663	20,745	20,749
Ashley County	23,178	23,494	23,691	23,869	23,874	24,186	24,209	24,209
Baxter County	40,330	39,803	39,115	38,760	38,427	38,466	38,386	38,386
Benton County	186,938	179,609	172,233	165,274	159,402	154,821	153,404	153,406
Boone County	35,793	35,165	34,748	34,648	34,364	34,062	33,948	33,948
Bradley County	12,192	12,327	12,428	12,463	12,515	12,603	12,600	12,600
Calhoun County	5,589	5,541	5,597	5,664	5,633	5,731	5,744	5,744
Carroll County	26,999	26,555	26,454	26,043	25,733	25,419	25,357	25,357
Chicot County	13,027	13,217	13,440	13,577	13,843	14,088	14,117	14,117
Clark County	22,916	23,055	23,147	23,442	23,608	23,500	23,546	23,546
Clay County	16,578	16,729	16,907	17,053	17,341	17,545	17,609	17,609
Cleburne County	25,391	25,041	24,725	24,424	24,211	24,108	24,046	24,046
Cleveland County	8,903	8,770	8,701	8,625	8,625	8,551	8,571	8,571
Columbia County	24,695	24,885	24,845	25,245	25,324	25,572	25,603	25,603
Conway County	20,739	20,568	20,519	20,461	20,424	20,332	20,336	20,336
Craighead County	86,735	85,791	84,650	83,718	83,007	82,496	82,148	82,148
Crawford County	57,630	56,641	55,612	55,005	54,174	53,395	53,247	53,247
Crittenden County	51,882	51,541	51,122	51,148	51,217	51,005	50,866	50,866
Cross County	19,237	19,106	19,186	19,336	19,539	19,490	19,526	19,526
Dallas County	8,524	8,672	8,708	8,832	9,033	9,157	9,210	9,210
Desha County	14,358	14,542	14,673	14,804	15,067	15,322	15,341	15,341
Drew County	18,693	18,595	18,592	18,418	18,703	18,709	18,723	18,723
Faulkner County	97,147	95,074	92,800	89,999	88,427	86,401	86,014	86,014
Franklin County	18,218	18,025	17,950	17,913	17,881	17,735	17,771	17,771
Fulton County	11,934	11,855	11,644	11,601	11,574	11,663	11,642	11,642
Garland County	93,551	92,222	91,189	89,980	89,218	88,384	88,068	88,068
Grant County	17,348	17,190	16,915	16,744	16,694	16,507	16,464	16,464
Greene County	39,401	38,863	38,436	38,027	37,777	37,513	37,331	37,331
Hempstead County	23,383	23,436	23,395	23,451	23,434	23,577	23,587	23,587
Hot Spring County	31,264	30,969	30,714	30,561	30,416	30,378	30,353	30,353
Howard County	14,552	14,423	14,454	14,299	14,290	14,267	14,300	14,300
Independence County	34,737	34,622	34,437	34,314	34,325	34,293	34,233	34,233
Izard County	13,430	13,311	13,336	13,189	13,273	13,277	13,249	13,249
Jackson County	17,601	17,684	17,443	17,737	17,834	18,357	18,419	18,418

Table 1: Annual Estimates of the Population for Counties of Arkansas: April 1, 2000 to July 1, 2005

Jefferson County	81,700	82,162	82,876	83,265	83,643	84,228	84,282	84,278
Johnson County	24,042	23,736	23,479	23,208	22,907	22,785	22,781	22,781
Lafayette County	8,027	8,149	8,335	8,332	8,394	8,543	8,559	8,559
Lawrence County	17,153	17,366	17,518	17,615	17,751	17,682	17,774	17,774
Lee County	11,545	11,667	11,891	12,265	12,419	12,536	12,580	12,580
Lincoln County	14,262	14,291	14,466	14,505	14,495	14,478	14,492	14,492
Little River County	13,227	13,232	13,403	13,421	13,383	13,625	13,628	13,628
Logan County	22,944	22,900	22,837	22,533	22,454	22,512	22,486	22,486
Lonoke County	60,658	58,623	56,721	55,298	54,087	53,161	52,828	52,828
Madison County	14,962	14,670	14,412	14,325	14,365	14,292	14,243	14,243
Marion County	16,735	16,469	16,234	16,231	16,305	16,174	16,140	16,140
Miller County	43,162	42,518	41,935	41,321	40,826	40,453	40,443	40,443
Mississippi County	47,911	48,377	48,920	50,207	51,081	51,852	51,979	51,979
Monroe County	9,302	9,418	9,658	9,743	9,959	10,178	10,254	10,254
Montgomery County	9,274	9,234	9,226	9,144	9,231	9,286	9,245	9,245
Nevada County	9,550	9,567	9,658	9,696	9,828	9,928	9,955	9,955
Newton County	8,452	8,485	8,592	8,502	8,518	8,639	8,608	8,608
Ouachita County	27,102	27,307	27,634	27,827	28,129	28,703	28,790	28,790
Perry County	10,468	10,435	10,388	10,425	10,327	10,246	10,209	10,209
Phillips County	24,107	24,350	24,583	25,062	25,753	26,282	26,445	26,445
Pike County	11,038	11,005	11,057	11,194	11,230	11,322	11,303	11,303
Poinsett County	25,349	25,273	25,393	25,404	25,594	25,625	25,614	25,614
Polk County	20,176	20,084	20,206	20,237	20,189	20,272	20,229	20,229
Pope County	56,580	56,007	55,291	55,199	54,852	54,490	54,469	54,469
Prairie County	9,113	9,163	9,318	9,431	9,517	9,511	9,539	9,539
Pulaski County	366,463	365,228	364,674	363,588	362,287	361,702	361,474	361,474
Randolph County	18,465	18,407	18,191	18,236	18,267	18,178	18,195	18,195
St. Francis County	27,902	28,160	28,479	28,623	28,822	29,289	29,329	29,329
Saline County	91,188	89,214	87,399	86,202	85,009	83,945	83,529	83,529
Scott County	11,150	10,999	11,009	11,016	11,012	11,010	10,995	10,996
Searcy County	7,969	7,971	7,956	8,092	8,214	8,276	8,261	8,261
Sebastian County	118,750	117,632	117,288	116,908	116,283	115,540	115,070	115,071
Sevier County	16,456	16,089	15,891	15,754	15,632	15,744	15,757	15,757
Sharp County	17,397	17,420	17,455	17,358	17,289	17,182	17,119	17,119
Stone County	11,716	11,641	11,611	11,548	11,439	11,535	11,499	11,499
Union County	44,186	44,536	44,881	45,197	45,129	45,578	45,629	45,629
Van Buren County	16,529	16,488	16,422	16,283	16,346	16,221	16,192	16,192
Washington County	180,357	174,265	169,628	165,532	162,413	158,651	157,717	157,715

Table 1: Annual Estimates of the Population for Counties of Arkansas: April 1, 2000 to July 1, 2005

White County	71,332	70,577	69,617	69,093	68,483	67,410	67,165	67,165
Woodruff County	8,098	8,135	8,286	8,426	8,680	8,695	8,740	8,741
Yell County	21,391	21,314	21,429	21,360	21,257	21,179	21,139	21,139

Note: The April 1, 2000 Population Estimates base reflects changes to the Census 2000 population from the Count Question Resolution program and geographic program revisions. Dash (-) represents zero or rounds to zero. (X) Not applicable

Suggested Citation:

Table 1: Annual Estimates of the Population for Counties of Arkansas: April 1, 2000 to July 1, 2005 (CO-EST2005-01-05)

Source: Population Division, U.S. Census Bureau

Release Date: March 16, 2006

State of Oklahoma • Office of the Secretary of the Environment

FACT SHEET: Poultry Litter and the Illinois River Watershed

Over the last three decades the poultry population of the Illinois River Basin has increased to over 250 million birds. This increase has coincided with a significant decline in water quality in the river, its tributaries, and Lake Tenkiller.

With the June 1996 release of the Tenkiller Phase I Clean Lakes Report, which determined that over 76% of the nonpoint source phosphorus loading to Lake Tenkiller resulted from manures produced by confined animal operations, the State of Oklahoma recognized that stopping runoff from litter application fields would be the key to halting further impairment of Illinois River and Tenkiller water quality. Clean Lakes reports for Lakes Eucha and Wister showed very similar results. In response, the State established an Animal Waste & Water Quality Protection Task Force which recommended a prohibition on manure runoff to waters of the state, incentives to encourage alternative uses of litter, and support for the Oklahoma Department of Agriculture's litter marketing program. The Legislature followed suit in 1998 by enacting the majority of the Task Force's recommendations into law.

In the six years that followed, government officials worked with poultry growers to find alternative markets for surplus litter, particularly in eastern Oklahoma watersheds dominated by poultry production. Efforts to connect producers with excess litter and farmers with nutrient needs were severely hampered by a lack of funding to cover loading and hauling expenses. Poultry integrators maintained that they were not responsible for these costs, and the already struggling poultry growers could not bear the cost themselves.

In response, the State and Federal government began subsidizing litter hauling from nutrient threatened watersheds to areas where it could be properly utilized, beginning in 2004 with the State's $5 per ton tax credit and the NRCS's manure transfer incentives. In 2005, Arkansas and Oklahoma created further incentives by establishing grant programs under section 319(h) that provided $1.7 million for litter hauling in the Illinois River, Wister, and Eucha watersheds. These interim grant programs have moved 8% of the litter out of the Illinois River watershed. All told, the litter hauling subsidies represent a commitment of $4.3 million, of which 88% is public funds and 12% private.

Illinois River Watershed At-A-Glance:

- number of poultry houses: 3,057[1]
- poultry litter generated annually: 542,948 tons[2]
- human population equivalent to poultry phosphorus production: 10.7 million people[3]
- actual human population of watershed municipalities in 2000: 195,314[3]
- litter generated annually in excess of estimated crop needs of land application sites: 418,070 tons (77% of annual production)[4]
- litter moved out since September 2005: 45,469 tons (8% of annual production)[5]

Estimates taken from the following sources:

[1] Office of the Secretary of the Environment, 2002. *Coordinated Watershed Restoration and Protection Strategy for Oklahoma's Impaired Scenic Rivers*, 116 pp.

[2] Based upon litter and birds produced per house by type of operation from BMPs, Inc., 2004. *Poultry Litter Production for Illinois River Watershed*, 1 p.

[3] Oklahoma Water Resources Board, 2002. *Illinois River Basin Tour*, 22 pp.

[4] Oklahoma Department of Agriculture, Food, & Forestry, 2006. *Strategy for Restoration and Protection of Scenic River Watersheds Through Nutrient Management of Agricultural Activities*, 6 pp.

[5] Letter from Janet Wilkerson, Peterson Farms, to Rick Stubblefield, Oklahoma Scenic Rivers Commission, July 20, 2006

Exhibit

"2"

Exhibit

"3"

Subject: 10/25/2006 Norman Transcript Article - "Chicken poop, money key ingredients in AG race"

Chicken poop, money key ingredients in AG race

The Norman Transcript

Transcript Staff Writer

OKLAHOMA CITY -- Somewhere in most modern political campaigns, the candidates accuse each other of slinging mud.

In the race for Oklahoma attorney general, the substance being slung is chicken poop -- lots and lots of chicken poop.

Farm groups, poultry producers, the governor of Arkansas and Republican attorney general candidate, James Dunn, all accuse incumbent Attorney General Drew Edmondson of using chicken poop for political reasons.

The groups site Edmondson's lawsuit against Arkansas poultry companies as proof of their claim, and accuse Edmondson of filing the suit solely for political reasons. Edmondson counters, saying the chicken litter from Arkansas poultry companies is fouling Oklahoma waterways and the producers won't do anything to stop the problem.

Recently Arkansas Gov. Mike Huckabee -- in town to raise money for Republican candidates -- accused Edmondson of "demonizing" the poultry industry. "Unfortunately, your attorney general is not interested in resolving the situation, he's more interested in headlines," Huckabee said in a published news story. "It's a great political platform for him."

Edmondson's opponent, James Dunn, echoed Huckabee.

Dunn said if he is elected attorney general he would move to immediately dismiss the suit.

"We need to protect our agricultural industry," he said earlier this year. "The attorney general's suit is a threat to that industry."

Edmondson, however, is unfazed.

"The issue is about water," he said. "The issue is simply about making sure Oklahoma has clean water -- nothing more."

"They're not fertilizing, they're dumping," Edmondson said in an interview with the Washington Post. "My concern is for the environment. My concern is for the lake and the river, which I'm watching being degraded before my eyes, literally."

Edmondson also had harsh words for Huckabee.

In a statement released following Huckabee's visit, Edmondson called Huckabee "a poultry company apologist" and said Huckabee "should be ashamed" of the poor job Arkansas has done in regulating the poultry industry.

"It is clear they (poultry producers) run his state," Edmondson said. "Just like me, most Oklahomans care more about clean water than anything Gov. Huckabee has to say."

And, Dunn, Edmondson said, isn't interested in clean water.

"James Dunn has done nothing to help Oklahomans," he said. "He would allow these companies to pollute the water."

Dunn countered, saying Edmondson's suit against out-of-state poultry producers was "just a license to steal...like he did last time."

"The poultry case is about the fees Edmondson wants to pay his buddy, Mike Turpen," Dunn said.

Earlier this year, Dunn said Edmondson's lawsuit "would devastate" the state's agriculture industry. He said the poultry industry, working with state officials in Oklahoma and Arkansas, could use a "cooperative spirit" to clean up pollution. "Oklahoma has a history of fixing problems," he said. "They (the poultry industry) could do like the Oklahoma Energy Resources Board. There, the oil industry cleaned up its abandoned well sites."

Dunn's charges have been echoed by various poultry groups in Arkansas and Oklahoma.

Keith Morgan, a spokesman for Poultry Partners, Inc., claimed a fact sheet presented to the Oklahoma Scenic River Commissioners by state Secretary of Environment Miles Tolbert -- on Edmondson's behalf -- was "a display of inaccurate information."

In an editorial printed this summer, Morgan said Tolbert and Edmondson "failed to do their jobs" in providing current and correct data for the commissioners.

As an example, Morgan cites the number of poultry houses and the tons of litter they produce.

"If the two didn't do their homework and they really don't know how many active poultry houses are in the watershed or how much litter is generated in those houses, that is a display of incompetence on their part," Morgan wrote. "We find it hard to believe they aren't aware of the number of poultry houses or tons of litter they are talking about."

Morgan claims there are only 1,694 poultry houses in the watershed, instead of the 3,057 number used by Edmondson.

The 1,694-house number was a "head count," Morgan said, conducted by the poultry industry as of 4 p.m. on Aug. 29.

Edmondson said Morgan's claim is wrong.

In fact, Edmondson said, he had the actual number of poultry houses counted.

"We sent investigators in the field and visually counted the number of houses," Edmondson said. "And that count was 3,057. I'm not going to go into court without the proper data. That's why went sent people to count the houses."

Surveys show the anti-chicken poop message is being well received.

An Oct. 9 poll from TVpoll.com -- which is owned by OU political science professor Keith Gaddy -- showed 54.9 percent of the voters supported Edmondson, while Dunn's support was listed at 30.2 percent. Undecided voters accounted for almost 15 percent. Those numbers, Edmondson said, prove he's doing the right thing.

"I don't live and die by polls," he said. "I don't make decisions that way. But that data shows me that Oklahomans are concerned about clean water and they want an attorney general who will work for them."

Still the chicken poop continues to fly.

Dunn says Edmondson is a major player in the "good ol' boy" network. "He's just trying to help his friends," the Luther Republican charges.

Those charges, Edmondson says, are bogus.

"Oklahoma politics is a contact sport," he said. "It's not easy, but I figured I've made the conservatives mad with my poultry lawsuit and I've made liberals mad with my stance on the death penalty -- so I believe I'm doing the right thing."

Agricultural Environmental Management Services
AEMS

Oklahoma Department of Agriculture,
Food, and Forestry
Agricultural Environmental Management Services
P. O. Box 528804
Oklahoma City, OK 73152

D. J. Parrish, Director, 405/522-4659

CORRECTED MEMORANDUM

Date: January 7, 2008

To: Rick Stubblefield

From: Sally Abbott
Administrative Programs Officer

Re: Open Records Request
Poultry House Numbers

Rick,

I am responding for D. J. Parrish.

There are 312 registered poultry houses in the Eucha-Spavinaw Watershed and 185 registered poultry houses in the Illinois River Watershed. These numbers are as of November 1, 2007. Poultry renewal registrations for poultry operations were due as of December 31, 2007, however all data entry has not been completed as of this date.

Thank you.

D. J. Parrish
Director,
Agricultural Environmental
Management Services

Exhibit
"4"

Arkansas Natural Resources Commission

J. Randy Young, PE
Executive Director

101 East Capitol, Suite 350
Little Rock, Arkansas 72201
http://www.anrc.arkansas.gov/

Phone: (501) 682-1611
Fax: (501) 682-3991
E-mail: anrc@arkansas.gov

Mike Beebe
Governor

During the 2007 PFO Registration period, there were approximately 1410 poultry houses registered in the Illinois River watershed.

Exhibit
"5"

Case No. CV 0900BA(K) U.S. District Court, Northern District of Oklahoma

Eucha/Spavinaw Watershed Management Team

P.O. Box 248
Decatur, AR 72722

Mandy Pirani
Tel: 479-752-3702
Fax: 479-752-3707 Cell: 479-752-7312
Email: mandypirani@cox-internet.com

August 31, 2006

As you requested per our phone conversation this morning, I am reporting to you the average amount of litter generated per poultry house as reported to the Eucha/Spavinaw Watershed Management Team by growers in 2005.

Based on these records, approximately 90 tons of litter is generated per poultry house. Poultry houses include broiler, hen, and pullet houses of various sizes. This average is based solely on what growers report to us, which may not always be accurate. Potential inaccuracy may result from growers assuming that a truck load of litter weighs a certain amount. The number of truck loads is then multiplied by the assumed truck weight to calculate a litter total. Also, many growers report only what they remove in a full-house clean-out and do not report any de-cake that may have been removed.

When estimating the amount of litter that was generated by a broiler house in one year, the ESWMT uses 120 tons/house. This number assumes regular de-caking and re-filling of bedding material.

Please let me know if I may be of further assistance.

Sincerely,

Mandy

Mandy Pirani, E/SWMT

Exhibit

"6"

Fall 2000 • Volume 2, Number 1

AVIAN Advice

UofA
UNIVERSITY OF ARKANSAS
DIVISION OF AGRICULTURE
COOPERATIVE EXTENSION SERVICE

Arkansas Is Our Campus

INSIDE

Avian Influenza: Always a threat in the fall

Dr. F. Dustan Clark
Extension Poultry Veterinarian

Background and History: Avian Influenza is a disease that can cause extremely high mortality in poultry. Outbreaks have cost the industry many millions to eradicate and the 1994-95 outbreak in Mexico that is still a problem in certain areas of that country. Costs can be devastating to producers since entire flocks can die in only a few hours after infection with a highly virulent strain of Avian Influenza. The costs associated with Avian Influenza outbreaks make it extremely important for the producer to be aware of the signs of the disease and take steps to prevent it.

The disease was first recognized in Italy in 1878 and was first reported in the United States in 1924 in New York City. An outbreak in Pennsylvania in 1983-84 was the most devastating disease outbreak in the recorded history of the U.S. poultry industry. It cost the industry an estimated $60 million to eradicate the disease and consumers about $349 million to replace the table eggs lost in the quarantine region.

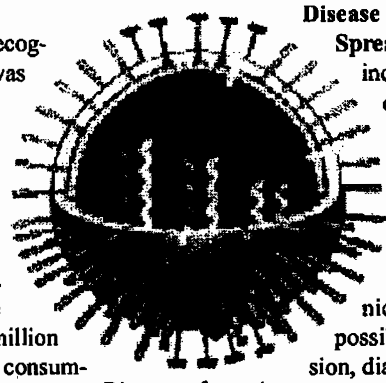


Diagram of an avian influenza particle

Virus Description: The older literature called Avian Influenza "Fowl Plague." A virus called an *Orthomyxovirus* causes Avian Influenza. The virus has two types of glycoproteins that project from the virus coat which may either protect the particle from destruction or allow it to adhere to a surface. These glycoproteins are called Hemmaglutinin (H) and Neuraminidase (N). There are 15 different types of H glycoproteins and nine different types of N glycoproteins. These H and N glycoproteins are used by poultry health professionals to tell one Avian Influenza virus strain from other types, such as H5N2. The viruses are also designated as low pathogenic and high pathogenic based on their ability to cause death in susceptible chickens. Thus you can have a virus designated H5N2 that causes low mortality and is called a low pathogenic type or you could have an H5N2 that causes high mortality and as such is called a high pathogenic type. However, the virus can change from a low pathogenic type to a high pathogenic type without warning.

Disease Symptoms Diagnosis and Spread: Avian Influenza has an incubation period of 3-7 days depending on the virus dose, poultry species infected, route of exposure, and several other factors. The symptoms exhibited by an infected bird are variable and depend on the pathogenicity of the virus. Some of the possible symptoms are: depression, diarrhea, dehydration, appetite loss, weight loss, huddling, a drop in egg production and respiratory symptoms (cough, sneeze, sinusitis). The lesions that could be observed include: a bloody nasal discharge, facial swelling, blue discoloration of the face, subcutaneous hemorrhages, tracheal inflammation, nasal inflammation and hemorrhages on the shanks and in the proventriculus. There is no acceptable or practical treatment for poultry infected with high pathogenic Avian Influenza infected poultry.

Avian Influenza is diagnosed by blood testing and virus isolation. Blood testing is

(continued on page 2)

Exhibit
"7"

(Avian Influenza: continued from page 1)

considerably more rapid and less expensive than virus isolation, but virus isolation is much more accurate than blood testing. Poultry found positive for the Avian Influenza virus are currently quarantined and destroyed to prevent spread to other flocks. Destruction of affected animals is the only viable method to control the spread of the disease.

The disease spreads from infected birds to non-infected birds via respiratory and gastrointestinal secretions. Susceptible birds can be exposed to respiratory or gastrointestinal secretions in numerous ways. Secretions can be spread on contaminated footwear, clothing, egg flats, equipment, cages, etc. In fact, Avian Influenza is most often spread from infected to non-infected flocks by people carrying the virus usually on their clothes or footwear. However, the virus can live for short periods on human skin or in human nasal passages. In addition, the virus can be shed by infected wild birds including migratory waterfowl (e.g. ducks and geese) or game birds, which show no clinical signs of the disease. The Avian Influenza virus has also been frequently isolated from clinically normal exotic birds. At moderate temperatures the virus can remain viable in organic materials for long periods of time and can survive indefinitely in frozen materials. ■

Steps to Prevent the Disease Exposure

1. Keep **"No Visitors"** and/or **"Restricted"** signs posted at the road entrance of the farm.
2. **Do not allow** visitors in the poultry houses or on the farm.
3. **All** farm personnel should wear **separate clothing** (including shoes, boots, hats, gloves, etc.) on the farm. Clothes used on the farm should **stay** on the farm.
4. **Completely change all clothing** after caring for the flock and wash hands and arms thoroughly before leaving the premises.
5. **Do not visit** other poultry farms or flocks or have contact with any other species of birds.
6. Keep all poultry houses securely locked. Lock all houses from the inside while working inside.
7. All equipment, crates, coops, etc., must be **thoroughly cleaned and disinfected** before and after use.
8. **All essential visitors** (owners, feed delivery personnel, poultry catchers and haulers, service men, etc.) are to wear protective outer clothing (coveralls), boots, and headgear prior to being allowed near the poultry flock or farm.
9. **Monitor all vehicles** (service, feed delivery, poultry delivery or removal, etc.) entering the premises to determine if they have been **properly cleaned and disinfected. This includes disinfection of the tires and vehicle undercarriage.**
10. Sick and dying birds should be submitted to a diagnostic laboratory for proper diagnosis of the problem. All commercial growers should contact their flock supervisor and follow their instructions.
11. **Dead birds** are to be **properly disposed** of by burial, incineration or other approved method.
12. Any person handling wild game (especially waterfowl) **must** completely change clothing and shower or bathe before entering the premises.
13. **Do not** borrow equipment, vehicles, etc., from another poultry farm.
14. **Do not visit** areas where Avian Influenza is a problem.

Diagram of Avian Influenza particle was obtained with permission from http://www-micro.msb.le.ac.uk/335/V.html

Tom Tabler • Broiler Unit Manager - Savoy
Center of Excellence for Poultry Science • University of Arkansas

Brooding Chicks in Colder Weather

Colder weather means that we, as producers, are faced with some decisions about brooding. A number of studies have shown that birds brooded at 80°F vs. 90°F weighed as much as 20% less at 10 days of age, had 10% higher feed conversion and were far more likely to exhibit symptoms of ascites (water belly) (Figures 1, 2, & 3). Yet brooding chicks means using fuel and fuel costs money. In fact, the fuel bill is usually the highest during colder weather so we spend our fuel dollars wisely.

ARE CHICKS WARM?

TEMPERATURE STRATIFICATION

When brooding chicks, we must always be aware of the fact that the environmental conditions we are sensing about five feet from the floor may be very different than those the chicks are experiencing two inches above the floor. Even though house temperatures appear to be adequate, many times producers notice chicks near the brooding curtain or in other locations throughout the house huddling and appearing to be cold.

When brooding chicks, we must always be aware of the fact that the environmental conditions we are sensing about five feet from the floor may be very different than those the chicks are experiencing.

This may be because the air three feet above the floor (where the temperature sensor hangs) may be four to seven degrees warmer than at floor level. So you think you are brooding at 86°F, but you may only be brooding at or about 80°F. This is primarily due to the fact that hot air is lighter than cold air so the hot air produced by brooders and furnaces collects at the ceiling while cold air leaking in from various cracks and other locations collects at the floor. The amount of stratification can depend upon how much the heating system is operating, house tightness and location within the house.

continued on page 4

Figure 1. Bird Weight and Brooder Temperature.

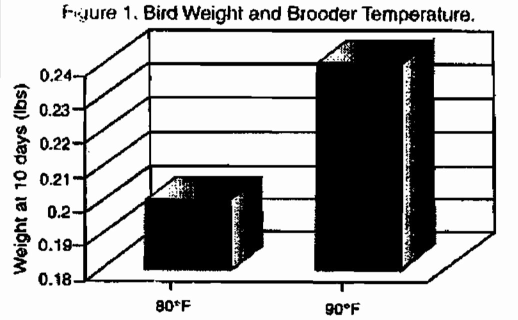


Figure 2. Brooder Temperature and Feed Conversion

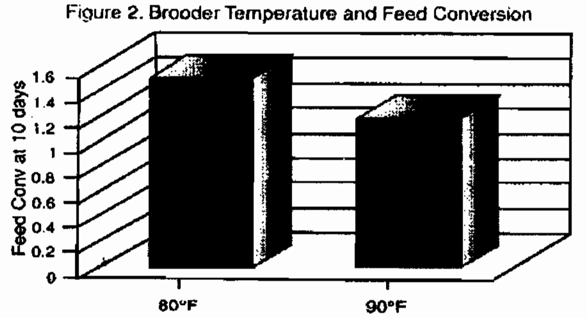
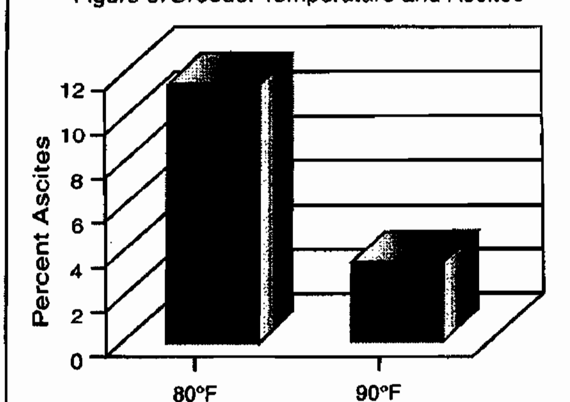


Figure 3. Brooder Temperature and Ascites



PROPER TEMPERATURE SENSOR PLACEMENT *(continued from page 3)*

Temperature stratification is a particularly bad problem with brooder/furnace thermostats since they are placed two to three feet above the floor. If a grower wants a house temperature of about 88°F he/she may set the thermostats, located a few feet above the floor, at 86°F. Stratification and drafts will probably result in a temperature at floor level being at least five degrees cooler. As a result, brooding temperature is actually closer to 80°F than 88°F.

In houses with radiant or conventional brooders the bird is warmed by both hot air and radiant heat emanating from the brooders. So if the air is a little cool in one location, chicks can move toward the brooders to warm themselves. But in houses with forced air furnaces, if the air temperature is too low the only way chicks can keep warm is by huddling because radiant heat is not an option. Obviously, huddling is not a good thing; the more chicks huddle the less they eat, drink and grow.

The best way to ensure that you are brooding at a proper temperature is to place sensors/thermostats three to four inches above the floor with baby chicks. This should be high enough that the chicks cannot reach them. Once the birds are a week to 10 days of age sensors/thermostats can be raised to two feet or so above the floor so the birds cannot peck at them or possibly sit on them. By this time brooders/furnaces are not operating quite as much, so stratification is less of a problem. Also, at older ages the birds are a little less sensitive to lower air temperatures. Moving your sensors will require some degree of extra management on your part but the results should prove beneficial to the health and well-being of the birds.

PROPER GAS PRESSURE

Something else to be aware of as winter approaches is the importance of having proper gas pressure. If you have difficulty maintaining the proper house temperature when you have young chicks and the outside temperature drops into the 20s or less even though your brooders are operating constantly, several possible explanations exist. It could be that your ceiling insulation is inadequate and needs to be increased, your house lets in too much unwanted air or you may be having to ventilate a great deal because there is too much ammonia in the house. However, another possibility is something not considered very often... insufficient gas pressure. Each brooder/furnace is designed to operate most efficiently at a specific gas pressure. When the gas pressure is too low not only do you get insufficient heat, but you may not get complete gas combustion resulting in the production of carbon monoxide. Conversely, if the pressure is too high the brooder could get too hot resulting in reduced life span. It is possible to have too much gas pressure, however, low gas pressure is more common. In general, gas pressure determines the amount of gas that flows to a brooder/furnace. The higher the gas pressure, the greater the amount of fuel burned by the brooder/furnace, and the greater the amount of heat produced. The opposite is also true ... lower pressure, less gas, less heat.

Forced air furnaces require a higher operating pressure than conventional brooders. The University of Arkansas Broiler Research Farm at Savoy has a combination of brooders and forced air furnaces in each of the four houses. The houses are heated by propane with two 1,000-gal storage tanks at each house. When gas pressure begins to drop due to inadequate propane in the tanks, the furnaces at the ends of the gas lines begin to burn inefficiently with a weak yellow flame instead of the normal strong blue flame. If the problem is not remedied by additional gas delivery to the tanks, the rest of the furnaces will eventually start to burn inefficiently followed by the brooders at the ends of the lines and finally the remaining brooders nearest the tanks.

Recent tests of radiant brooders at the University of Georgia have shown that relatively small drops in gas pressure can have a significant effect on the amount of heat radiant brooders produce. Reducing gas pressure from a manufacturers specified 11" of water column (for propane) to 9" reduced radiant heat output from the brooder by approximately 13%. When gas pressure was reduced from 11" to 7" radiant heat output was reduced by 30%. Finally, when gas pressure was reduced from 11" to 5" radiant heat output was reduced by nearly 40%.

It should be obvious that having low gas pressure hurts producers in two ways; it reduces the amount of radiant heat a brooder produces as well as the amount of hot air a brooder/furnace produces, both of which are very important in keeping chicks warm during cold weather. Improper gas pressure not only affects heat output but also gas usage. Furnaces/brooders burn fuel most efficiently when gas pressure is adjusted correctly. Remember that low gas pressure will affect heat output of not only radiant brooders, but conventional brooders and forced air furnaces as well.

If you think that you may have a gas pressure problem check with the manufacturer of the brooder/furnace or your local equipment installer on proper procedure for checking gas pressure as well as information on possible causes of low gas pressure (i.e., proper gas line sizing both inside and outside your house, proper amount of propane in your tanks). Then, if necessary, call your local gas company to set up a time for them to check your gas pressure. The gas pressure needs to be checked at the last brooder/furnace on the gas line with all the brooders/furnaces operating.

SUMMARY AND CONCLUSIONS

With the arrival of fall and the approaching onset of winter try to find some time in your schedule to evaluate such things as your thermostat/sensor locations, gas pressure, tightness and durability of your brooding curtains, and the condition of your side wall curtains. Also, if you do not have stir or mixing fans in your house moving hot air from the ceiling to the chicks, consider getting them. If you have them be sure to use them. Our research shows that stir fans have one of the fastest pay backs of any investment, and the higher the gas prices, the quicker the payback. A thorough evaluation could pay huge dividends in fuel savings and bird performance as we enter another winter season. ■

Grateful appreciation is extended to Michael Czarick and Michael Lacy, University of Georgia Cooperative Extension Service, for portions of the information contained herein.

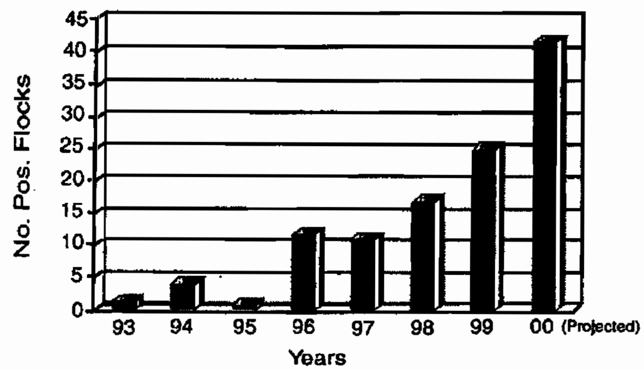
F. Dustan Clark • Extension Poultry Veterinarian
Center of Excellence for Poultry Science • University of Arkansas

Mycoplasmosis -- A Continued Threat

The data in Figure 1 indicate that there has been a continued steady increase in outbreaks of Mycoplasma in Arkansas poultry in the last few years. In fact, if the trend continues, there will be a record number in Arkansas during 2000. The purpose of this article is to discuss symptoms and effects of the disease in poultry, help poultry producers better recognize the disease and prevent the spread of mycoplasmas to other poultry flocks.

Mycoplasma are small bacteria that can cause disease in a variety of poultry species.

Figure 1. Mycoplasma in Arkansas Poultry Flocks



Data collected by the Arkansas Livestock and Poultry Commission

Mycoplasma are small bacteria that can cause disease in a variety of poultry species. There are four species of mycoplasma that affect commercial poultry: *Mycoplasma gallisepticum* (MG), *Mycoplasma synoviae* (MS), *Mycoplasma meleagridis* (MM) and *Mycoplasma iowae* (MI). The first two species (MG and MS) are responsible for the current mycoplasma problems in Arkansas poultry.

Mycoplasma gallisepticum (MG) causes a respiratory disease in chickens and turkeys infecting the sinuses, air sacs, trachea and bronchi of the bird after an incubation period of 1-3 weeks. Chickens with the disease have a cough, eye inflammation (conjunctivitis) and a nasal discharge. A drop in egg production can also be seen in breeders and layers. Turkeys usually have a severe swelling of the sinuses, nasal discharge and frothy eyes. Affected chickens and turkeys do not gain well and may die or be downgraded at slaughter. The disease can be much more severe when birds with mycoplasmosis are also infected by bacteria such as *E. coli* or viruses. The disease is almost always more severe in turkeys than in broilers.

Mycoplasma synoviae (MS) can also cause a respiratory infection. In addition, MS can infect the joints and tendon sheaths of the bird. Chickens infected with MS have reduced growth, swollen joints (hocks) and footpads, and may breast blisters. While air sacculitis (air sac infection) can occur and chickens may show respiratory distress, MS usually does not cause any symptoms when the respiratory tract is infected. Turkeys have similar signs and lesions to broilers, but usually lameness is the most predominant problem. As with MG the problem is more severe when bacteria or viruses also infect the birds.

Several methods are used to diagnose the disease in poultry. The clinical signs and lesions can be used to make a presumptive diagnosis, which is confirmed by isolation of the bacteria, blood testing and/or specialized tests such as the Polymerase Chain Reaction (PCR test) on tracheal swabs.

continued on page 6

MYCOPLASMOSIS-- *continued from page 5*

Successful treatment of mycoplasma infections is unpredictable since there is a great deal of variation in the sensitivity of mycoplasma to antibiotics. There are vaccines available for use in MG infections, but since they are live vaccines there is concern that the vaccine strain will spread to other birds. In fact, many states do not allow vaccination for MG or at least restrict vaccine use since most MG vaccine strains have shown a potential to spread to unvaccinated chickens and turkeys. There has been little use of vaccination for MS infections. The preferable method of controlling mycoplasma infections is prevention.

Preventative measures are designed to exclude the bacteria from the flock. One step in excluding mycoplasma from flocks is maintaining clean breeder stock. This is done in the poultry industry by the National Poultry Improvement Plan, which is a testing and control program for egg transmitted diseases such as MG and MS. This program has been extremely successful nationwide and the majority of poultry in the United States are mycoplasma free. Unfortunately, a few problems still arise and as such an increased awareness and biosecurity are needed. Points to remember for better biosecurity are as follows:

1. Restrict visitor access to only necessary visitors.
2. All visitors should wear protective gear (including coveralls, boots or boot covers and headgear) that can be disposed of or disinfected on the farm.
3. Foot dips should be available on each farm at each poultry house.
4. Do not share equipment, egg flats, etc., between farms.
5. Vehicles should be cleaned and disinfected between farms.
6. Wildlife and vermin should be restricted from poultry houses.

Naturally, all points of an on-farm biosecurity program should be reviewed and followed and a good cleaning and disinfection program should be in place to prevent any disease. If mycoplasmosis is suspected in your birds, it is important to immediately contact supervisor/service personnel so a diagnosis can be made and appropriate procedures can be implemented. Prevention is always more economical than treatment and early recognition of a problem can prevent spread of a disease from house to house or farm to farm. ■

Tom Tabler • Broiler Unit Manager - Savoy
Center of Excellence for Poultry Science • University of Arkansas

How Much Litter Do Broilers Produce?

Due to increasing environmental concerns regarding land application of animal wastes and the high replacement cost of new bedding materials, poultry producers are looking more at the option of reusing old litter for an extended period of time. The University of Arkansas Broiler Research Farm at Savoy recently concluded an extended period of reusing old litter in which litter in House 1 was used to produce18 flocks of birds while litter in Houses 2, 3 & 4 each grew 12 flocks of birds without cleanout or topdressing. Caked litter was removed from each house after each flock with a decaking machine. Total loads of caked litter removed were recorded for each house after each flock for future reference. In an effort to document as closely as possible the exact amount of litter produced during this extended reuse period, portable scales were used to weigh each load of litter removed from each broiler house during the total cleanout. Number of loads of dry litter removed as well as total weight removed (in pounds and tons) from each house was then calculated. (Table 1.)

Table 1. Dry Litter Removal from Savoy Broiler Houses

House No.	No. Flocks	Lbs/ House	Tons/ House	Loads/ House
1	18	421,850	210.93	33
2	12	431,440	215.72	38
3	12	315,650	157.83	27
4	12	391,330	195.67	32[1]
ALL		1,560,270	780.15	130

[1]An additional 8,170 lbs (4.09 tons) was removed from House 4 with a farm tractor for use in deep-stacking research.

A private contractor using commercial spreader trucks with 16-ft beds removed 106 loads of litter to predetermined best management sites after each load was weighed. The same contractor removed 24 dump bed loads that were deep-stacked on-site in preparation for additional research. An additional 4.09 tons were also removed from House 4 and added to the deep-stacked litter using a farm tractor. The 106 spreader truckloads averaged 5.78 tons per load. In addition to litter removed at cleanout, weight of caked litter removed since the last cleanout was also estimated for each house (Table 2). These weights were based on an average weight of 3500 pounds per decaker load as determined by portable scales.

Table 2. Estimated Caked Litter Removal Since Last Cleanout

House No.	No. Flocks	Lbs/ House	Tons/ House	Loads/ House
1	18	159,250	79.63	45.5
2	12	147,000	73.50	42.0
3	12	220,500	110.25	63.0
4	12	101,500	50.75	29.0
ALL		628,250	314.13	179.5

In addition to decaking, House 1 also had old litter removed from the non-brood end in October 1999 for an off-site research trial. Based on weights at cleanout, this litter would have equaled approximately 44 tons. The total amount of litter removed from each house since the previous cleanout is indicated in Table 3. This includes original bedding material placed in each house that was not weighed at time of placement, litter removed prior to cleanout and all litter removed during the recent total cleanout. Previous cleanouts were May 1996 for House 1 and October 1997 for Houses 2, 3 & 4. Table 3 also contains the percentage of the litter removed as caked litter as well as the percentage removed as dry litter.

During the summer of 1998, the fogging nozzles in House 3 had worn to the point that they were putting out much more water than the normal 2-gals/hr-flow rating. This caused an excess amount of water to be added to the litter that summer, which was later removed as cake. This is evident in Table 2 by the additional loads of caked litter removed from House 3 and in Table 3 by the increased percentage of caked litter removed from that house. New nozzles were installed in the spring of 1999 preventing any such problem that summer.

continued on page 8

Table 3. Total Litter Removal Since Previous Cleanouts

House No.	No. Flocks	Lbs/ House	Tons/ House	Caked (%)	Dry (%)	Tons/ Flock	Tons/ year[1]
1	18	669,100[2]	334.55[3]	23.80	76.20	18.59	92.95
2	12	578,440	289.22	25.41	74.59	24.10	120.5
3	12	536,150	268.08	41.13	58.87	22.34	111.7
4	12	492,830	246.42	20.60	79.40	20.53	102.7
ALL		2,276,520	1138.27	27.60	72.40	21.07	105.4

[1] Assuming 5 flocks/year
[2] Includes 88,000 lbs of litter removed for a research trial
[3] Includes 44 tons of litter removed for a research trial

A rule of thumb is that each broiler house will generate approximately 100 tons of litter per year. Based on data presented here, that rule appears slightly conservative, but reliable (Table 3). While not cleaning out for an extended period such as this will create some monetary savings where new bedding is concerned, it creates costs in other areas. Therefore, each producer must answer the following questions for him/herself to determine if extended litter usage is a viable option:

A rule of thumb is that each broiler house will generate approximately 100 tons of litter per year.

1) Do I need litter for fertilizer each year or is extended use something I might consider? If pastures and/or hay fields have been receiving chicken litter applications, commercial fertilizer may be necessary as a nutrient replacement. Commercial fertilizer would then be an added cost if litter were reused for an extended period.

2) Will extra ventilation to remove ammonia cost more than having new litter at least once a year? Our observations were that after about a year the ammonia levels reached a plateau. They did not get worse the longer we were on reused litter, but how much better would we have done if we did not have to ventilate for ammonia? During cold weather, ammonia problems caused us to have to pull more air than the birds actually needed in order to get rid of the ammonia. This over ventilation was more expensive than simply pulling in the amount of air the birds needed for respiration.

3) Will extended usage cause increased condemnation problems? We observed a gradual increase in condemnation percentage as the litter got older. Not every flock had a higher condemnation percentage than the previous flock, but the pattern was a steady increase over time. Condemnation percentages the first six months on the litter ranged from .50% to .75%, while the last six months prior to cleanout ranged from 1.35% to 1.87%. Additional factors influence condemnation percentage, but it is likely that the longer a farm goes without a total cleanout, washdown and disinfect program, the greater the disease challenge on that farm. This disease challenge may make it more difficult for subsequent flocks to perform up to their potential. This is especially true if other critical management areas such as environmental quality or biosecurity are compromised.

In conclusion, land application of animal waste will continue to be a sensitive environmental issue in the future. Federal, state and local authorities continue to look at where, when and how much animal waste may be applied to given locations. Producers should be aware of and follow voluntary best management practices developed for their area concerning animal waste application. Questions exist that each individual poultry producer must answer for him/herself when considering reusing old litter for an extended time period. Information presented here should be of value in regards to the amount of litter produced by broiler chickens and may be helpful by pointing out some of what has been observed at the Broiler Research Farm during extended litter usage. ■

The author gratefully acknowledges Dr. Tom Costello, Biological and Agricultural Engineering Department, Fayetteville, for assistance with data collection and Dr. Karl VanDevender and Paul Ballantyne, Cooperative Extension Service, Little Rock, for use of the portable scales.

Tom Tabler • Broiler Unit Manager -Savoy
Center of Excellence for Poultry Science • University of Arkansas

Savoy Broiler Unit Performance Report

The first flock at the Savoy Broiler Unit was placed on November 19, 1990. The unit contains four 40 x 400 foot broiler houses. Each house contains Cumberland pan feeders, Ziggity nipple waterers and about 1.5 million BTU propane heating capacity for brooding. Each house is equipped with a computer controller, which controls fans, brooders and curtains for temperature control. Houses are also equipped with temperature monitoring equipment (about 80 sensors per house), an electronic water flow monitoring system, weigh bins for feed delivery to the house, sensors for the monitoring of fan run time and devices to determine gas flow from storage tanks.

Houses 1 and 2 were built with steel trusses with R10 insulation in the ceiling while houses 3 and 4 were constructed with wood trusses, R19 ceiling insulation and drop ceilings. Houses 1 and 3 are conventionally ventilated with misters for summer cooling, but 2 and 4 are tunnel ventilated. House 2 contains a "sprinkler" cooling system for summer cooling. The system was developed at the University of Arkansas and uses a landscape sprinkler system to deliver a coarse, cooling mist to the backs of the birds. House 4 uses evaporative cooling pads to cool the inlet air.

Information Key

Variable	Units	Explanation
HSE	No.	House number
FEED CONV	LB/LB	Feed conversion or pounds of feed per pound of gain
HEAD PLACED	No.	Number of chicks place in the house at the beginning of grow-out.
HEAD SOLD	No.	Number of birds sent to the processing plant
LIV	%	Livability or Head sold/Head placed * 100
AGE	D	Age of birds at processing in days
AVE BIRD WT	LBS	Average live bird weight at processing
COND	%	Percentage of birds condemned by the government inspector at the plant. Condemned birds are not fit for human consumption.
FEED COST	$	Feed costs in dollars
CHICK COST	$	Chick costs in dollars
MED COST	$	Medication Costs in dollars
TOTAL COST	$	Total costs in dollars
COST/LB	Cent	Total costs per pound of live bird weight in cents per pount
PAY/LB	Cent	Payment received from the poultry company in cents per pound.
F.A.	$	Fuel allowance-a payment provided by the poultry company to help defray heating fuel costs
GAS USAGE	GAL	Propane usage in gallons
ELECT	KWH	Electrical usage in kilowatt hours

MANAGER'S COMMENTS ON FLOCK 50

House 2, with its unconventional sprinkler cooling system, once again produced the heaviest chicken. This has been the case for most hot weather flocks since this system was installed in 1995. While somewhat different compared to most cooling systems, we have been quite pleased with results we have achieved. House 1 had the best feed conversion and the greatest return and House 2 with the heaviest chicken had the second greatest return. Caked litter removed after the flock was as follows: House 1 – 2 loads, House 2 – 5 loads, House 3 – 3 loads and House 4 – 3 loads. House 2 with its unique sprinkler system did have the most caked litter to remove but not so much as to create problems in the house. The House 2 sprinkler system is capable of putting out much more water than any of our other cooling systems and this fact does appear beneficial to the birds. It does have the potential to create caking problems; however, if managed properly by precisely timing the water output and pulling enough air over the birds, caked litter can be kept in check and the birds continue to eat and gain weight in hot weather.

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PRODUCTION SUMMARY: FLOCK 50 (August 5, 1999 - September 29, 1999)																
HSE (No)	FEED CONV (LB/LB)	HEAD PLACED (No)	SOLD (No)	HEAD LIV (%)	AGE (D)	WT (LB)	AVE BIRD COND (%)	FEED COST ($)	CHICK COST ($)	MED. COST ($)	TOTAL COST ($)	COST/LB (Cent)	PAY/LB (Cent)	F.A.[1] ($)	GAS USAGE (GAL)	ELECT USAGE (KWH)
1	2.08	18109	17384	96.00	55	6.10	1.87[2]	11053	3079	23.60	14155	13.594	3.7813	0.00	264	4167
2	2.13	18309	17296	94.47	55	6.26	1.87	11540	3113	23.60	14676	13.803	3.5727	0.00	168	4456
3	2.16	18409	17302	93.99	55	6.00	1.87	11242	3130	23.60	14395	14.122	3.2533	0.00	99[3]	4460
4	2.11	18409	17474	94.92	55	6.08	1.87	11220	3130	23.60	14373	13.778	3.5974	0.00	209	3463
FARM	2.12	73236	69456	94.84	55.0	6.11	1.87	45054	12450	94.40	57599	13.822	3.5529	0.00	740	16546

1 F.A. = Fuel allowance
2 Condemnation percentage could not be divided by house
3 Lower gas usage and increased electrical usage in House 3 is a reflection of wood pellet furnace

MANAGER'S COMMENTS ON FLOCK 51

House 1 had both the heaviest chicken and best feed conversion. These factors allowed House 1 to also have the greatest return on this flock. The wood burning pellet furnace was once again in use in House 3. This is apparent by the lesser amount of gas usage in that house compared to the other houses. Data collection on the furnace system will now continue until spring 2000. Caked litter removal after the flock sold was as follows: House 1 – 1 load, House 2 – 1 load, House 3 – 1 load and House 4 – 1 load. Litter was quite dry and dusty. As litter depth has increased, fewer loads of caked litter are removed.

PRODUCTION SUMMARY: FLOCK 51 (October 12, 1999 - December 3, 1999)																
HSE (No)	FEED CONV (LB/LB)	HEAD PLACED (No)	SOLD (No)	HEAD LIV (%)	AGE (D)	WT (LB)	AVE BIRD COND (%)	FEED COST ($)	CHICK COST ($)	MED. COST ($)	TOTAL COST ($)	COST/LB (Cent)	PAY/LB (Cent)	F.A.[1] ($)	GAS USAGE (GAL)	ELECT USAGE (KWH)
1	2.03	19631	18318	93.31	52	6.00	1.35[2]	11153	3337	50.70	14541	13.418	4.1961	0.00	1119	1372
2	2.11	19612	18048	92.03	52	5.45	1.35	10348	3334	50.70	13732	14.162	3.4518	0.00	620	1561
3	2.13	19250	18446	95.82	52	5.32	1.35	10459	3272	50.70	13782	14.225	3.3888	0.00	271[3]	3075
4	2.13	18991	18012	94.84	52	5.67	1.35	10870	3228	50.70	14149	14.049	3.5649	0.00	834	1876
FARM	2.10	i/484	72824	93.99	52.0	5.61	1.35	42830	13172	202.80	56205	13.949	3.6651	0.00	2844	7884

1 F.A. = Fuel allowance
2 Condemnation percentage could not be divided by house
3 Lower gas usage and increased electrical usage in House 3 is a reflection of wood pellet furnace

MANAGER'S COMMENTS ON FLOCK 52

House 2 had the heaviest chicken, best feed conversion and, in turn, the greatest monetary return. Pellet furnace usage greatly affected gas consumption in House 3. All houses were cleaned out, washed down and disinfected after an extended period of reusing old litter. House 1 grew 18 flocks of birds without cleanout or topdressing. Houses 2, 3 & 4 each grew 12 flocks without cleanout or topdressing. Previous cleanouts were May 1996 for House 1 and October 1997 for Houses 2, 3 & 4. Condemnation percentage has steadily eased upward as litter has gotten older.

PRODUCTION SUMMARY: FLOCK 52 (December 20, 1999 - Feb.7 [House 2] & 8 [Houses 1,3 & 4], 2000)																
HSE (No)	FEED CONV (LB/LB)	HEAD PLACED (No)	SOLD (No)	HEAD LIV (%)	AGE (D)	WT (LB)	AVE BIRD COND (%)	FEED COST ($)	CHICK COST ($)	MED. COST ($)	TOTAL COST ($)	COST/LB (Cent)	PAY/LB (Cent)	F.A.[1] ($)	GAS USAGE (GAL)	ELECT USAGE (KWH)
1	2.08	18806	18027	95.86	50	5.21	1.74[2]	9791	3197	181.29[4]	13169	14.268	3.5247	378	1867	1342
2	1.94	18868	17995	95.37	49	5.75	1.74	10024	3208	181.29	13413	13.198	4.5948	378	1553	2090
3	1.98	18813	17871	94.99	50	5.33	1.74	9425	3198	181.29	12804	13.668	4.1247	378	519[3]	3282
4	2.08	18862	18012	95.49	50	5.18	1.74	9705	3207	181.29	13093	14.290	3.5026	378	2365	2067
FARM	2.02	75349	71905	95.43	49.75	5.37	1.74	38945	12809	725.16	52479	13.838	3.9544	1512	6304	8781

1 F.A. = Fuel allowance
2 Condemnation percentage could not be divided by house
3 Lower gas usage and increased electrical usage in House 3 is a reflection of wood pellet furnace
4 Medication cost includes disinfectant and litter beetle control costs related to cleanout

MANAGER'S COMMENTS ON FLOCK 53

Flock 53 was marked by high mortality as indicated by a livability of only 92.46%. This was due in part to early chick mortality and partially to respiratory problems late in the flock as indicated by a condemnation percentage of 2.63%. This was the first flock after a complete clean out, wash down and disinfection of all houses. Houses 2 & 4 tied for the heaviest weight at 5.62 lbs, however, House 2 had the best feed conversion and the greatest dollar return. Many of the respiratory problems were in House 4 causing it to have a 2.24 feed conversion and the lowest monetary return. Caked litter removed with the decaker after the flock sold was: House 1 - 3 loads, House 2 - 10 loads, House 3 - 5 loads and House 4 - 10 loads.

PRODUCTION SUMMARY: FLOCK 53 (March 13, 2000 - May 3 [House 1, 2 & 3] & 4 [House 4], 2000)

HSE (No)	FEED CONV (LB/LB)	HEAD PLACED (No)	SOLD (No)	HEAD LIV (%)	AGE (D)	WT (LB)	AVE BIRD COND (%)	FEED COST ($)	CHICK COST ($)	MED. COST ($)	TOTAL COST ($)	COST/LB (Cent)	PAY/LB (Cent)	F.A.[1] ($)	GAS USAGE (GAL)	ELECT USAGE (KWH)
1	2.16	19065	17651	92.58	51	5.23	2.63[2]	9988	3241	33.18	13262	14.745	3.5496	000	1290	1687
2	2.12	19111	17844	93.37	51	5.62	2.63	10631	3249	33.18	13913	14.246	4.0489	000	856	1913
3	2.18	19069	17866	93.69	51	5.51	2.63	10740	3242	33.18	14015	14.627	3.6678	000	756[3]	2851
4	2.24	19165	17289	90.21	52	5.62	2.63	10892	3258	33.18	14184	14.989	3.3063	000	1323	1761
FARM	2.18	76410	70650	92.46	51.25	5.50	2.63	42252	12990	132.70	55374	14.647	3.6477	000	4225	8212

1 F.A. = Fuel allowance
2 Condemnation percentage could not be divided by house
3 Lower gas usage and increased electrical usage in House 3 is a reflection of wood pellet furnace

MANAGER'S COMMENTS ON FLOCK 54

Flock 54 was highlighted by the best quality baby chicks we have had in quite some time. The weather caused some major problems as it stayed cool and rainy for the first six weeks of the flock and very hot and dry the last two weeks. Birds were not acclimated to the heat and, as a result, we lost 1003 birds in House 4 (cool cell house) the last seven days of the flock. We are currently discussing possible options involving modifications to House 4. Even with the heat loss, the flock as a whole did quite well. House 3 had the heaviest chicken at 6.30 lbs but House 2 (with its unconventional summer sprinkler system) was close behind with a 6.24 lb bird and a much better feed conversion of 2.08 allowing it to have the greatest return. House 3 made only slightly less money than House 1. House 4, with all its heat loss problems, had the smallest payback, the lightest bird and the highest feed conversion. The unconventional sprinkler system in House 2 used 5,271 gals of water during the flock compared to the cool cell system in House 4 which used 35,510 gals of water. Caked litter removed after the flock was as follows: House 1 - 4 loads, House 2 - 8 loads, House 3 - 10 loads and House 4 - 6 loads. ■

PRODUCTION SUMMARY: FLOCK 54 (May 15 [Houses 1 & 2] 16 [Houses 3 & 4], 2000- July 10 [Houses 1, 2 & 4] & 11 [House 3], 2000)

HSE (No)	FEED CONV (LB/LB)	HEAD PLACED (No)	SOLD (No)	HEAD LIV (%)	AGE (D)	WT (LB)	AVE BIRD COND (%)	FEED COST ($)	CHICK COST ($)	MED. COST ($)	TOTAL COST ($)	COST/LB (Cent)	PAY/LB (Cent)	F.A.[1] ($)	GAS USAGE (GAL)	ELECT USAGE (KWH)
1	2.16	18557	17459	94.08	56	6.05	1.92[2]	11385	3155	45.50	14586	14.083	4.2183	000	218	4868
2	2.08	18891	17905	94.78	56	6.24	1.92	11627	3211	45.50	14884	13.594	4.7081	000	208	4716
3	2.16	19118	18263	95.53	56	6.30	1.92	12451	3250	45.50	15747	13.953	4.3488	000	151[3]	6688
4	2.18	19355	17593	90.90	55	5.77	1.92	11083	3290	45.50	14419	14.488	3.8132	000	344	4516
FARM	2.15	75921	71220	93.81	55.75	6.09	1.92	46547	12906	182.00	59636	14.017	4.2842	000	921	20788

1 F.A. = Fuel allowance
2 Condemnation percentage could not be divided by house
3 Lower gas usage and increased electrical usage in House 3 is a reflection of wood pellet furnace

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Low-Cost, Temporary Poultry Litter Storage

Most poultry growers realize that dry poultry litter is a valuable by-product of production. Yet applications of poultry litter to hay fields and pasture lands generally supply more phosphorus than the crop can use. To avoid long-term phosphorus buildup in soils and the associated pollution risk, many farmers are seeking off-farm markets for litter. Storage systems are often necessary to provide flexibility in clean-out scheduling and off-farm transport arrangements.

Poultry litter storage systems must be economical for the grower and maintain environmental protection while retaining litter quality. Excessive temperatures during storage (as litter goes through a 'heat' cycle similar to composting) can degrade litter quality and lead to safety concerns (spontaneous combustion). Allowing litter to be wetted by rain or runoff can lead to odors, pests, degradation of quality and loss of product. Current environmental regulations in Arkansas also dictate that dry animal manure be stored in a way that keeps it dry and isolated from natural rainfall and runoff. Hence, some method of cover is required unless the farmer has a permit to manage the litter as a liquid waste.

Storage alternatives include permanent structures (e.g., traditional wood frame or pole structure with sheet metal roof) or temporary systems (e.g., outdoor litter pile with tarp cover). Some estimated costs are shown in Table 1. Costs can be spread over the life of the structure, during which litter from several clean-outs may be successfully stored. For example, if the temporary system was put in place for 100 tons of storage capacity, the initial cost would be $450. If the tarp lasted three years and was used three times, then the cost would be $150 per year or $1.50 per ton of litter stored. Reduced costs often make temporary storage techniques more practical when large volumes of litter must be stored for short periods. One objective of on-going work at the U of A has been to configure a covered pile that effectively stores litter, but is inexpensive and easy to construct and maintain.

Table 1. Cost of Litter Storage Alternatives

Construction Type	Life Exp. (years)	Cost ($/ft²)	Cost ($/ton)
permanent wood structure, steel roof	20+	$6.50	$105
semi-permanent steel tubing structure, polyethylene cover	5 - 10	$3.50	$56
temporary free-standing wind-row, polyethylene cover	2 - 5	$0.30	$4.50

FIELD TESTING

Two low-cost, temporary litter storage systems were constructed and monitored at the University of Arkansas Broiler Research Unit near Savoy, Arkansas, in February, 2000. One pile was a free-standing wind-row of litter (Figure 1) and the other was a bunker built from two rows of large round hay bales (Figure 2). Piles were each covered with a 6 mil polyethylene, 30 ft x 60 ft, plastic tarp (Poly-Tec Hay Tarps[1]).

The free standing wind-row and the round bale bunker method of temporary litter storage appeared equally effective in this trial. While more litter could be stored in the bunker bale method, construction of the bunker required considerable time and expense. Based on our field experience, the free-standing, covered litter pile seems to be the best choice for a grower to temporarily store litter outside for a few weeks or months. The technique is inexpensive, easy to construct, maintains litter quality and protects the environment.

Figure 1. Free-standing wind-row litter storage system with tarp cover. Pile cross-section has dimensions 20 ft. bottom width, 3 ft. top width and 6 ft height. Tarp is 30 ft. wide, 6 mil thick, 3-ply polyethylene. Sandbags placed every 2 to 3 foot along the perimeter hold the tarp down.

Figure 2. Hay bunker litter storage system with tarp cover. Two rows of large round bales were used to form bunker walls. Outside width of bunker is 20 ft. (10 ft. between bales). Litter is piled about 2 ft above the top of the 5-ft diameter bales to a total depth of 7 ft. Same tarp as described in Figure 1. Tarp was originally held down using grommets and ropes every 2 ft (left side of photo) and tires and ropes ever 4 ft (right side of photo). Both of these methods failed during heavy wind. Pile was eventually held successfully using grommets and ropes with sandbags added on top to counteract the lift forces of the wind.

Steps in Implementing Temporary Litter Storage

1. Estimate the Amount of Litter to Move

The quantity of litter removed during full-house clean-out depends directly on the number of flocks of birds that have been grown since the last clean-out. Table 2 gives guidelines for planning temporary systems for storing dry poultry litter from full-house clean-out, based on our tests at Savoy. Our data is based on multi-year re-use of bedding/old litter. Between flocks, no bedding was added and caked-litter was removed. Broilers were grown to an age of 6-8 weeks. To include storage for caked litter removed between flocks, estimate cake litter as an additional 6 tons per 16,000-ft² house per flock. All litter weights are on the as-is moisture basis. Table 2 also shows that the average litter depth increases roughly 5/8 inch per flock. Knowing the bulk density of the litter and the depth, the total litter weight and volume in the house can be estimated. These data can then be used to estimate the number of truckloads of litter that will be removed during clean-out and to size the storage structure. The storage structure is assumed to be a free-standing pile, 6 ft tall with a 20 ft bottom width and 3 ft top width.

Example. A broiler farmer has five broiler houses, 40 ft x 400 ft, on a clean-out schedule of once every two years (about 12 flocks). How much litter will be removed and how much storage space will be needed? Refer to Table 2.

- ❒ Litter depth: assume 8 inches
- ❒ House area: equivalent to five 16,000-ft² houses
- ❒ Litter weight: 188 tons x 5 = 940 tons total
- ❒ Pile length: 134 ft x 5 = 670 ft

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[1] Poly-Tec Hay Tarps, Walk-Winn Plastics, Little Rock, Arkansas. Mention of a name brand product in no way endorses that product nor implies that other similar products are not appropriate for use.

POULTRY LITTER STORAGE *continued from page 13*

If the same grower alternated clean-outs so that one house can be cleaned out every five months, then the storage capacity required and the storage costs could be reduced by a factor of 5 (188 tons, 134 ft of storage).

To estimate litter weight, volume and storage requirements for turkeys or cornish hens, at the time of clean-out, measure the litter depth carefully throughout the house and take an average. Choose the closest litter depth from Table 2 and use the estimated litter weights and volumes for that depth. This assumes that the bulk density of the litter will be similar to the broiler litter we monitored at Savoy. This should give a good estimate for planning purposes.

Table 2. Guidelines for Dry Poultry Litter Storage Planning

				Litter Removed (per 16,000 ft^2 house)		Storage Needed (per 16,000 ft^2 house)	
No. of Flocks	Litter Depth (inches)	Bulk Density (lbs/ft^3)	Areal Density (lbs/ft^2)	Total Weight (tons)	Spreader Truck Loads	Total Volume (ft^3)	Length of Pile (ft)
1	1.6	38.5	5.1	31	5	1400	34
2	2.2	39.6	7.3	44	8	1900	42
3	2.8	40.7	9.5	57	10	2500	50
4	3.4	41.8	11.8	71	12	3200	59
5	4.0	42.8	14.3	86	15	3800	69
6	4.6	43.9	16.8	101	18	4500	78
7	5.1	45.0	19.1	115	20	5100	87
8	5.7	46.1	21.9	131	23	5800	98
9	6.3	46.4	24.4	146	25	6500	107
10	6.9	46.4	26.7	160	28	7100	116
11	7.5	46.4	29.0	174	30	7700	125
12	8.1	46.4	31.3	188	33	8400	134

Notes: Based on 6-8 week flocks of broilers. Areal density is the weight of litter in the house per ft^2 of floor area. Weight of litter actually removed is only 75% of the amount estimated to be in the house, due to incomplete clean-out, spillage, experimental error. A spreader truck usually hauls 5.75 tons of litter. The bulk density of litter placed in a pile is about 45 lb/ft^3. The recommended litter pile has cross-sectional dimensions of 20 ft bottom width, 3 ft top width and 6 ft height.

2. Properly Site and Construct the Pile

Locate the storage system close to the poultry houses to minimize travel time during clean-out/construction. Choose a site that is relatively flat (less than 5% slope) on high ground that will not intercept overland flow of rainfall/runoff water from upstream land. Orient the pile with the long axis in the direction of the greatest slope. Be sure that the pile is surrounded by a 100 ft buffer zone of well established grass with no rocky outcrops, creeks, streams, sink holes or other water sources. Avoid building on soils which have excessive leaching capacity or shallow depth. If possible, select a site which is protected from the wind by trees or some other wind-break (this will reduce potential problems with the tarp blowing off).

Unload litter from the truck along the pile centerline. Between truck unloadings, use a front-end loader to move the litter, piling it higher to build the desired cross-section. It should not be necessary to shape the pile with the tractor from the sides. The natural slope of dry litter (about 37°) should form a pile about 20 ft wide when a maximum depth of 6-6.5 ft is attained (deeper piles are at risk for over-heating). More than one pile may be needed, depending upon the total volume of material, the topography of the site and the length of the available tarp.

3. Correctly Cover the Pile

A pile 6 ft tall, 20 ft bottom width and 3 ft top width will require a 30 ft wide tarp. The length of the tarp will, of course, depend on the length of the pile. When determining tarp length, be sure to allow enough tarp length to cover both ends of the pile. Our experience indicates that a tarp thickness of 6 mils with a UV inhibitor will provide a tarp life greater than one year (the manufacturer suggests a five year life if tarp is well maintained). Clear plastic tarps should be avoided to reduce solar heating of the piles. Less expensive plastic sheeting may be used but the material will degrade quickly, will probably need to be disposed of after a single storage period, will tend to rip easily and could fail during extended storage periods.

Recruit several people to help unroll the tarp and place it over the pile. Adjust the tarp so that overlap is equal on both sides of the pile. Have some weights ready along the sides of the pile to hold down the tarp temporarily while it is put into position. We recommend that the tarp be held down using weights along the perimeter. Sandbags placed every 2-3 feet have worked very well in our tests. (Tires are not heavy enough if placed only on the perimeter, they also present a disposal problem at the end of the storage period). With a free-standing pile, grommets/ropes and stakes are not easy to install since there are no sidewalls. Commercial sandbags

A simple system of temporarily storing poultry litter can be used to protect product quality and prevent negative environmental impacts.

(empty) can be purchased or one could get new or used plastic/fiberglass feed sacks. Feed sacks seem to deteriorate quicker than sandbags. Fill partially with sand or soil and tie off with twine. Once in place, the bags will not abrade the tarp. Sandbags are preferred over steel pipe, concrete blocks or other weights that could potentially damage mowing machinery if left in the field.

4. Maintain the Pile

Under normal weather conditions, the covered pile should hold up well, keeping the litter dry and preventing contamination of rain or runoff water. After storm events, check the tarp and readjust as necessary. Pull out any slack (and eliminate any low spots that puddle water) that may have developed from wind action. This will prolong tarp life by reducing abrasion associated with tarp billowing. Re-position sandbags as necessary.

5. Reclaim the Litter

At the end of the storage period, roll back the tarp as needed to uncover a section of the pile. Load the litter onto the trucks for transport off the farm. Re-cover the end of the pile if the next load will be removed at a later date. After the pile has been completely loaded out, gather any residual litter, load into a spreader and land apply locally in a manner approved for land application of dry poultry litter. Carefully fold the dry tarp and store for re-use.

SUMMARY

A simple system of temporarily storing poultry litter can be used to protect product quality and prevent negative environmental impacts. A free-standing litter pile, about 20 ft wide and 6 ft deep, can be covered with a tarp, 30 ft wide, 6 mil thick. Sandbags placed every 2-3 ft along the perimeter will hold the tarp in place. Litter from an annual clean-out of a typical 40 ft x 400 ft broiler house can be stored temporarily in an 80 ft long pile, costing approximately $450 for materials. If the tarp is well maintained, the cost of the system can be spread over several years use and many hundreds of tons of stored litter.

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AVIAN ADVICE

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POSC 0-114, Fayetteville, AR 72701

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Graphic Designer: Karen Eskew

UA Poultry Science Extension Specialists

Dr. Dustan Clark, Extension Poultry Health Veterinarian, earned his D.V.M. from Texas A&M University. He then practiced in Texas before entering a residency program in avian medicine at the University of California Veterinary School at Davis. After his residency, he returned to Texas A&M University and received his M.S. and Ph.D. Dr. Clark was director of the Utah State University Provo Branch Veterinary Diagnostic Laboratory prior to joining the Poultry Science faculty at the University of Arkansas in 1994. Dr. Clark's research interests include reoviruses, rotaviruses and avian diagnostics. He is also responsible for working with the poultry industry on biosecurity, disease diagnosis, treatment and prevention.

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Dr. Frank Jones, Extension Section Leader, received his B. S. from the University of Florida and earned his M. S. and Ph.D. degrees from the University of Kentucky. Following completion of his degrees Dr. Jones developed a feed quality assurance extension program which assisted poultry companies with the economical production of high quality feeds at North Carolina State University. His research interests include pre-harvest food safety, poultry feed production, prevention of mycotoxin contamination in poultry feeds and the efficient processing and cooling of commercial eggs. Dr. Jones joined the Center of Excellence in Poultry Science as Extension Section Leader in 1997.

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Dr. John Marcy, Extension Food Scientist, received his B.S. from the University of Tennessee and his M.S. and Ph.D. from Iowa State University. After graduation, he worked in the poultry industry in production management and quality assurance for Swift & Co. and Jerome Foods and later became Director of Quality Control of Portion-Trol Foods. He was an Assistant Professor/Extension Food Scientist at Virginia Tech prior to joining the Center of Excellence for Poultry Science at the University of Arkansas in 1993. His research interests are poultry processing, meat microbiology and food safety. Dr. Marcy does educational programming with Hazard Analysis and Critical Control Points (HACCP), sanitation and microbiology for processing personnel.

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Dr. Susan Watkins, Extension Poultry Specialist, received her B.S., M.S. and Ph.D. from the University of Arkansas. She served as a quality control supervisor and field service person for Mahard Egg Farm in Prosper, Texas, and became an Extension Poultry Specialist in 1996. Dr. Watkins has focused on bird nutrition and management issues. She has worked to identify economical alternative sources of bedding material for the poultry industry and has evaluated litter treatments for improving the environment of the bird. Research areas also include evaluation of feed additives and feed ingredients on the performance of birds. She also is the departmental coordinator of the internship program.

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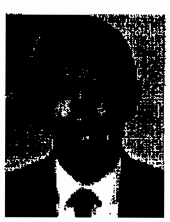

Mr. Jerry Wooley, Extension Poultry Specialist, served as a county 4-H agent for Conway County and County Extension Agent Agriculture Community Development Leader in Crawford County before assuming his present position. He has major responsibility in the Arkansas Youth Poultry Program, and helps young people, parents, 4-H leaders, and teachers to become aware of the opportunities in poultry science at the U of A and the integrated poultry industry. He helps compile annual figures of the state's poultry production by counties and serves as the superintendent of poultry at the Arkansas State Fair. Mr. Wooley is chairman of the 4-H Broiler show and the BBQ activity at the annual Arkansas Poultry Festival.

Address: Cooperative Extension Service, 2301 S. University Ave., P.O. Box 391, Little Rock, AR 72203

Telephone: 501-671-2189, FAX: 501-671-2185, E-mail: jwooley@uaex.edu

Write Extension Specialists, except Jerry Wooley, at:
Center of Excellence for Poultry Science
University of Arkansas
Fayetteville, AR 72701

Coming Events

September 12-14, 2000
Arkansas Nutrition Conference, Clarion Hotel, Fayetteville, AR
Contact: The Poultry Federation at (501) 375-8131

September 15-16, 2000
Turkey Symposium; Inn of the Ozarks, Eureka Springs, AR
Contact: The Poultry Federation at (501) 375-8131

September 20-21, 2000
Poultry Production and Health Seminar, the Sheraton Hotel, Birmingham, AL
Contact: U.S. Poultry & Egg Association at (770) 493-9401

October 6-15, 2000
Arkansas State Fair, State Fair Grounds, Little Rock, AR
Contact: State Fair office at (501) 372-8341

October 16-18, 2000
National Poultry Waste Management Symposium, Fountainbleau Hotel, Ocean City, MD
Contact: Nick Zimmerman at (410) 651-9111 or Rich Reynells at (202) 401-5352

January 17-19, 2001
International Poultry Exposition, Georgia World Congress Center, Atlanta, GA
Contact: U.S. Poultry & Egg Association at (770) 493-9401

STATEMENT OF JOINT PRINCIPLES AND ACTIONS

WHEREAS the States of Arkansas and Oklahoma share a number of streams and rivers that flow from Arkansas into Oklahoma, six (6) of which are designated as Scenic Rivers in the State of Oklahoma;

WHEREAS the States of Arkansas and Oklahoma share a common goal of improving water quality within the States' shared watersheds;

WHEREAS the States of Arkansas and Oklahoma agree that excess nutrients from point and non-point sources can result in nutrient surplus for phosphorus and nitrogen;

WHEREAS excess phosphorus in watersheds is known to degrade water quality and threaten aquatic life;

WHEREAS Arkansas and Oklahoma agree that reducing the amount of phosphorus present in the States' shared watersheds will further the States' shared goal of improving water quality;

WHEREAS, in an effort to reduce the amount of phosphorus present in its Scenic Rivers, the State of Oklahoma has passed, and submitted to the United States Environmental Protection Agency for approval under Section 303(c) of the Clean Water Act, a total phosphorus criterion of .037 mg/l for its six (6) Scenic Rivers, modified by an implementation schedule that allows dischargers to undertake interim actions designed to improve water quality in the Scenic Rivers... consistent with achieving compliance with the State of Oklahoma's .037 mg/l criterion for phosphorus, by 2012;

WHEREAS, Arkansas has steadfastly insisted and maintains that the .037 mg/l criterion for total phosphorus is neither attainable nor appropriate;

WHEREAS, Arkansas and Oklahoma agree that individual but coordinated strategies to meet water quality goals is in the best interest of both States;

The States of Arkansas and Oklahoma, acting through their environmental agencies, including, but not limited to, the Arkansas Department of Environmental Quality, the Arkansas Soil and Water Conservation Commission, the Oklahoma Secretary of Environment, the Oklahoma Water Resources Board, the Oklahoma Department of Environmental Quality and the Oklahoma Scenic Rivers Commission, are working together to reduce phosphorus in the shared Scenic Rivers Watersheds. In furtherance of that goal, the States of Arkansas and Oklahoma, acting through their environmental agencies, enter into this Statement of Joint Principles and Actions.

Exhibit
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ARKANSAS LEGISLATION

In furtherance of the States' shared phosphorus reduction goals, the Arkansas General Assembly enacted significant legislation to improve the States' shared watersheds. Consequently, the Arkansas Soil and Water Conservation Commission is committed to developing regulations to implement the following recently passed Arkansas legislation:

- Act 1059 of 2003, requiring the Arkansas Soil and Water Conservation Commission to develop and implement programs to certify the minimal competence and knowledge of persons preparing nutrient management plans and of persons making nutrient application, including the proper utilization of litter,

- Act 1060 of 2003, requiring the Arkansas Soil and Water Conservation Commission to operate an annual registration program to assemble and maintain information on the number, composition, and practices of poultry feeding operations in the state, including the land application practices used by each individual poultry feeding operation, as well as the amount of litter stored, applied and transferred by each operation, and

- Act 1061 of 2003, declaring certain areas, including the Illinois River Watershed, to be nutrient surplus areas for phosphorus and nitrogen, and making it a violation of State law to apply designated nutrients within a nutrient surplus area except in compliance with a nutrient management plan approved by the Arkansas Soil and Water Conservation Commission or at a protective rate established by Arkansas Soil and Water Conservation Commission.

LITTER REMOVAL/REUSE TECHNIQUES

The States of Arkansas and Oklahoma, acting through their environmental agencies, will jointly pursue funding, including federal grants or other federal funding, for various litter removal and reuse techniques, such as:

- the development of a litter bank;
- burning litter for energy;
- the use of biological treatment (e.g. the Stamper Project);
- pelletization to produce a marketable fertilizer product: and

transportation of excess litter from the affected watersheds.

JOINT PHOSPHORUS INDEX

The States of Arkansas and Oklahoma, acting through their environmental agencies, are working together toward development of a Joint Phosphorus Index by August 2004. The States will consider utilization of the Joint Phosphorus Index for the development of Nutrient Management Plans.

DATA COLLECTION

Although information collected pursuant to Act 1060 of the 2003 Arkansas General Assembly, quantifying the amount of litter stored, applied and transferred by individual poultry feeding operations is made confidential under the statute, the Arkansas Soil and Water Conservation Commission will prepare detailed compilations and summaries of this information and make these compilations and summaries available upon request to the public, the Oklahoma Environmental Agencies and EPA.

The Arkansas Soil and Water Conservation Commission will work with Oklahoma in determining the format for these compilations and summaries (e.g., information by county, geographic area or watershed), as well as the amount of detail necessary to address Oklahoma's reasonable concerns. Similarly, Oklahoma will work with Arkansas to provide comparable information for poultry operations in Oklahoma.

WATERSHED MONITORING

The States of Arkansas and Oklahoma, acting through their environmental agencies, will coordinate monitoring in partnership with the Arkansas/Oklahoma Arkansas River Compact Commission throughout the shared Oklahoma Scenic Rivers Watersheds based on a common protocol and will share all information/data resulting from such monitoring. The States will hold discussions aimed at arriving at the agreed upon monitoring protocol by August 2004.

The States will submit the agreed upon design to EPA for review and endorsement.

EPA has committed to seek to obtain federal funding for the agreed upon monitoring.

REOPENER PROVISION

Oklahoma periodically reevaluates all of its water quality standards. In particular, Oklahoma will reevaluate Oklahoma's .037 mg/l criterion for total phosphorus in Oklahoma's Scenic Rivers by 2012, based on the best scientific information available at that time, and with the full, timely inclusion of officials from the State of Arkansas representing both point and non point source dischargers.

CONTROLS ON LARGER ENTITIES

The States of Arkansas and Oklahoma, acting through their environmental agencies, understand that point source dischargers will need time to achieve water quality improvements in the affected watersheds consistent with Oklahoma's criterion for total phosphorus. Therefore, the States, acting through their environmental agencies, will issue to the point source dischargers to the shared Oklahoma Scenic Rivers Watersheds with a design capacity of greater than 1 MGD, specifically the Cities of Fayetteville, Rogers, Springdale, Siloam Springs and Bentonville, Arkansas, National Pollutant Discharge Elimination System ("NPDES") permits reflecting an effluent limit for total phosphorus of 1 mg/l (30 day average) pursuant to the implementation schedule set out below. The City of Tahlequah, Oklahoma received an NPDES permit issued in 1992 requiring it to meet a total phosphorus effluent limit of 1 mg/l.

The States of Arkansas and Oklahoma, acting through their environmental agencies, will reissue the above-specified cities' NPDES permits on a normal five (5) year reissuance cycle, with the understanding that NPDES permits for these point source dischargers to the shared Oklahoma Scenic Rivers Watersheds issued in the year 2012 or beyond must include phosphorus limits stringent enough to meet applicable water quality standards.

Schedule for Large Cities

Rogers – to meet 1 mg/l limit starting in 2004
Springdale – expansion to meet 1 mg/l limit starting in 2007
Siloam Springs – expansion to meet 1 mg/l limit starting in 2009
Fayetteville – existing facility already complies; new facility to meet 1 mg/l limit once operational (circa 2005)
Bentonville – new facility to meet 1 mg/l imit once operational (date unknown).

CONTROLS ON SMALLER ENTITIES

The State of Arkansas, acting through its environmental agencies, will work aggressively throughout the implementation period with those existing Arkansas entities with design capacities of less than 1 MGD but greater than or equal to .5 MGD to reduce the level of phosphorus in their discharges to the maximum extent possible through voluntary controls aimed at reaching either 1 mg/l total phosphorus or a phosphorus loading limit based on 1 MGD x 1 mg/l by the year 2012. The City of

Westville, Oklahoma is currently under a compliance order to meet a 1 mg/l limit within two (2) years.

NOTE: The States of Arkansas and Oklahoma, acting through their environmental agencies, understand that the above described controls do not apply to facilities, such as cooling water intake facilities, whose discharges do not contribute phosphorus to the receiving stream, so long as those facilities discharges do not contain increased concentrations of phosphorus.

WATERSHED PLAN

The States of Arkansas and Oklahoma, acting through their environmental agencies, will work together in partnership with the Arkansas-Oklahoma Arkansas River Compact Commission toward the goal of producing a Watershed Plan.

NOTE: EPA's Clean Water Act Section 319 guidance sets out nine (9) elements for a Watershed Plan.

GENERAL PROVISIONS

The parties understand that this document is not intended to create, diminish or waive any legal rights or obligations among the parties or any other person or entity not a party to this document, including individual farmers. Nothing in this document creates any rights of causes of action for any person, whether party to this document or not.

The parties recognize that a request by Oklahoma for more stringent NPDES permit concentration limits than those set out in this document, or a challenge by Arkansas to Oklahoma's phosphorus standard, would terminate this document. If a third party brings a lawsuit inconsistent with the terms of this document, both parties will indicate to the Court their support for the terms of this document.

EPA has told the parties this document represents a very positive step by the States, acting through their environmental agencies, toward improving water quality in the shared Oklahoma Scenic Rivers Watersheds, which is consistent with achieving compliance with the State of Oklahoma's .037 mg/l criterion for total phosphorus in the State's Scenic Rivers.

The States of Arkansas and Oklahoma, acting through their environmental agencies, understand that as parties to this document, they intend to respect and follow the commitments made herein, and that so long as all commitments made herein are met, the parties will continue to seek progress under this document toward achieving improvements in water quality.

Marcus C. Devine
Executive Director
Arkansas Department of Environmental Quality

December 18, 2003
Date

J. Randy Young, P.E.
Executive Director
Arkansas Soil & Water Conservation Commission

12/18/03
Date

STATEMENT OF JOINT PRINCIPLES AND ACTIONS

Miles Tolbert
Oklahoma Secretary of Environment

12/18/03
Date

12-18-03; 4:33PM ; EC;# 5
12-18-03; 2:02PM;OSE ;405+530+8999 # 3/ 3
12/18/2003 THU 09:14 FAX 011/012

Duane A. Smith
Duane A. Smith
Executive Director
Oklahoma Water Resources Board

12/18/03
Date

Edward H. Fite, III
Executive Director
Oklahoma Scenic Rivers Commission

12/18/2003
Date

STATEMENT OF JOINT PRINCIPLES AND ACTIONS PAGE 12

Steven A. Thompson
Executive Director
Oklahoma Department of Environmental Quality

12-18-03
Date

BMPS INC.

Post Office Box 1086/Farmington, AR 72730
Phone 866-304-2784 Fax 479-267-0079

October 22, 2007

Oklahoma Scenic Rivers Commission
Attn: Commissioners

RE: Illinois River Watershed Poultry Litter Export

Commissioners:

During the period of September 2006 through August 2007, BMPs Inc. has tracked poultry litter exports out of the Illinois River watershed in the amount of 74,256 tons. This accounts for more than 2.2 million pounds of phosphorus not land applied in the watershed.

Best Regards,

Sheri Herron
Executive Director

GOT POOP?

Exhibit

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OKLAHOMA LITTER MARKET

Promoting a better understanding of the movement and application of poultry litter in Oklahoma

Fact sheets on poultry litter.

EXTENSION

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Online Database

Buyers (185)

Sellers (29)

Service Providers (31)

Additional Tools

Fertilizer Value Calculator

Message Board

Top 5 reasons why you should join the Oklahoma Litter Market:

- It's Free
- It's Easy
- You Can Make a Sale
- You Can Make Money
- It Benefits the Environment

Join the Litter Market

Log in to join the Oklahoma Litter Market. It's fast and easy! Just fill out the questionnaire regarding your needs / services / product, or call the ODAFF hotline at 1-800-583-7131, or visit with your local Extension Educator (go to http://www.countyext.okstate.edu to find the nearest office), or email us at staff@ok-littermarket.org and we'll set up a profile for you.

How to Use the Site

Browse the database by clicking on Sellers, Buyers, or Service Provider links shown at left to see a complete list of our current members. Click on any of the links above to learn more about poultry litter, current Oklahoma regulations, for current news or to communicate directly with other producers / applicators in the state. You may also access other sites by visiting our links page.

Disclaimer

The Oklahoma Litter Market website serves as a communication link for buyers, sellers and service providers of poultry litter. Marketing poultry litter to more distant nutrient-deficient areas or for further processing offers one solution to the litter surplus problem associated with high production areas. The goal of this site is to provide educational materials, maps, guides, practical information and avenues of contact with producers, buyers, sellers and service providers. Listing your company on the Litter Market website does not imply approval for or participation in any subsidy or incentive programs. Applications for incentives are available from the sponsoring agencies or organizations.

Acknowledgements

Development of this site was funded by a grant from U. S. EPA 319(h), administered by the Oklahoma Conservation Commission as part of the Oklahoma Nonpoint Source Program. Oklahoma Department of Agriculture Food and Forestry provides assistance through the Oklahoma Litter Hotline 1-800-583-7131.

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Exhibit

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OKLAHOMA LITTER MARKET

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Visit our online database now!

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Welcome to Real-Time Buyer Data!

This is a list of all buyers in our database. If you want to sort records by buyer name, county name, phone or amount of litter needed, please, click on the appropriate column's name. If you want to see the details about each buyer, please, click on that individual's name.

Currently there are **185** Buyers in our database.

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19

Name	County	Phone	Email	Amount Needed
Lyle Blakley	Rogers	918-693-5768		1500
Rodney Blankenship	Choctaw	580-345-2384		200
Bill Bledsoe	Pawnee	918-738-4163		600
Gary Bledsoe	Lincoln	405-258-0783		400
BMPs, Inc.	Washington	866-304-2784		2000
BMPs, Inc.	Washington	866-304-2784		2000
BMPs, Inc.	Washington	866-304-2784		2000
David Boyer	Webbers Falls	918-464-2818		100
Russ Branan	Muskogee	918-683-17[illegible]5		200
Robert Branch	Logan	405-586-2420		800

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Name	County	Phone	Email	Amount Needed
casey abernathy	ottawa	918-674-2591		2000
Ray Albert	Nowata	918-857-0720		300
Roy Alford	Latimer	918-754-2451		500
David Allen	Tulsa	918-381-4393		75
Lenzie Anderson	Hughes	405-452-3335		200
Harvey Arnold	Atoka	580-889-7897		100
Troy Atkin	Pittsburg	918-426-4116		4000
Andy Barrett	Muskogee	918-682-02[illegible]3		400
Black Fox Ranch	Cherokee	918-366-6165		
Morgan Blair	Tulsa	918-251-8857		210

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Name	County	Phone	Email	Amount Needed
RC Brinlee	Latimer	918-465-5050		350
James Brockriede	TEXAS	940-495-3333		1000
Richard Brown	McIntosh	918-474-3246		350
Joe Brozovich	Latimer	918-297-3796		300
Jeff Buffington	Leflore	918-962-3650		2000
Allen Burris	Keota	0--		100
Steve Cashon	Creek	918-381-2508		50
George Cheek	Caddo	405-247-6685		100
Albert Chisum	Creek	918-267-5015		50
April Chitwood	Leflore	918-653-2912		

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Name	County	Phone	Email	Amount Needed
Lena Collard	Hughes	405-645-2561		500
Don Collins	Pushmataha	580-298-2623		100
Raymond Cook	Bixby	918-369-3956		100
Henry Travis Cosgrove	McIntosh	918-429-2505		300
Jay Crocker	Bryan	580-847-2589		100
Everett or Anna Culvey	Pushmataha	580-587-2515		300
Johnny Daniels	Adair	918-422-5848		100
Kirk Darnell	Washington	918-333-9944		400
J.G. Dearrington	Delaware	918-253-6464		500
Diane Dickinson	Rogers	918-342-2520		100

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Name	County	Phone	Email	Amount Needed
David Dixon	Okmulgee	918-733-2559		450
Louise Duvall	Henryetta	918-466-3622		100
Noah Easton 7	Tulsa	918-366-8930		50
James Elmenhorst	McIntosh	918-474-3218		100
Katherine England	Rogers	918-341-5731		100
Jim Enis	Latimer	918-465-3388		100
Danny Erbe	wilson	620-332-7513		330
Claud Evans	Okfuskee	918-623-1166		80
Jim Fairchild	Pittsburg	918-686-4128		100
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Name	County	Phone	Email	Amount Needed
Bill Fansler	Craig	918-788-3811		2000
Rich Falkenstien Farms	Labette	620-423-1796		2000
Rich Falkenstien Farms	Labette	620-423-1796		2000
Grossman Farms	Mayes	918-373-1856		5000
Marshall Farrier	Adair	918-723-4500		800
Sam Fleming	Choctaw	580-566-2097		250
Mike Ford	Cherokee	918-431-1035		100
Jerry E. Foreman	Ofuskee	918-623-1272		100
Mitch Fram	Cherokee	918-868-2802		35
mitch fram-2	Cherokee	918-868-2802		40

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Name	County	Phone	Email	Amount Needed
Franklin Ventures L.L.C.	Craig	918-256-8444		250
David Friesen	Major	580-542-4963		160
Sam Gentry	LeFlore	918-647-4355		2000
Kenneth Gibbens	Okmulgee	918-733-2916		2000
Donald Gibson	Boynton	918-733-4155		100
mike giles	rogers	918-645-3225		150
Ed Gipson	Mayes	918-825-4370		160
Jim Gist	Spiro	0--		100
John Gosney	Major	580-227-0114		100
John Gowdy	Creek	918-352-1648		70

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Name	County	Phone	Email	Amount Needed
Greener Pastures Enterprises LLC	Adair	918-723-4440		10000
Darin Griffin	Yale	405-746-1100		100
Keith Grissom	Seminole	405-382-7678		100
Norm and Cindy Haase	Choctaw	580-326-3779		100
Terry Hardin	Atoka	580-889-5590		100
G.W. Harmon	Creek	918-367-9227		100
Emmitt Harrison	Stephens	580-658-6457		100
Jim Harrison	Ok	918-651-3358		100
Don Hassell	Holdenville	405-257-3602		100
Charles Hatfield	Ottowa	479-273-3921		200

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Name	County	Phone	Email	Amount Needed
Larry Hensley	Haskell	918-469-3386		100
Abe Herschberger	Coal	580-428-3108		100
Bob Hightower	Pawnee	918-738-4362		100
Jan Hotubbee	Pittsburg	918-426-6986		600
R. Mark Hoyle	Bryan	972-816-2901		100
Earl Ingram	Pontotoc	580-436-4370		500
Bill Inhofe	Muskogee	918-683-2936		100
Charles James	Coal	580-428-3206		100
Don Jeans	Kay	580-363-5550		500
Jim Johnson	Choctaw	580-224-6431		800

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Name	County	Phone	Email	Amount Needed
Jim Johnson	Choctaw	580-224-6431		800
Kim Johnson	Coal	580-265-9653		100
Derek Johnson	Pottawatomie	405-850-1005		2500
Gary Jones	Rogers	918-371-0191		40
Larry Jones	Cherokee	918-598-3368		800
Don Kappel	Pottawatomie	405-567-1437		100
Kenneth Kasiner	Haskell	918-768-3372		500
Dr Phil Keeter	Adair	918-696-4065		
Jerry Kerr	Muskogee	918-686-6185		100
Basil Kesterson	Polk	870-385-2387		1000

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Name	County	Phone	Email	Amount Needed
Ulon Killmer	Okfuskee	405-786-2653		40
Rex Koelsch	Tulsa	918-445-5220		50
Gary Larson	Ottawa	918-666-3435		1000
Kevin Lee	McIntosh	918-618-4775		100
Jon Leeds	Muskogee	918-781-9020		1000
Tracy Lieblang	muskogee	918-687-2482		80
Tracy Lieblang	muskogee	918-687-2482		80
Tracy Lieblang	muskogee	918-687-2482		80
Dean Linville	Pawnee	918-243-7490		100
Andrew Livingston	Montgomery	620-331-0090		1000

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Name	County	Phone	Email	Amount Needed
James Long	Creek	918-378-5282		50
Jen Massey	Creek	918-367-8907		300
D.E. McCarty	Rogers	918-342-2962		100
Leon McClendon	Kiowa	918-432-5115		100
Henry McCoy	Delaware	918-326-4538		140
Eugene Meeks	Muskogee	918-687-9520		1000
JEARL MEEKS	TULSA	918-743-5419		150
Stan Metelko	LeFlore	918-658-3402		200
Danny Meyer	Byars	405-833-6232		100
Ralph Miller	Choteau	918-476-5486		100

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Name	County	Phone	Email	Amount Needed
Rick Miller	Sequoyah	918-235-0114		
Charles Montgomery	Tulsa	918-371-5267		40
Jack Mooney	Craig	918-783-5515		600
Paul Moore	Muskogee	918-260-2930		100
W.D. morey	ottawa	918-674-2488		1000
wayne morey	ottawa	918-674-2488		1000
Larry Morgan	Pushmataha	580-298-2812		100
Jim Morrill	Delaware	918-422-8952		100
Brent Morton	Adair	877-722-3339		10000
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Name	County	Phone	Email	Amount Needed
Harry Murphy	Oklahoma	405-842-7177		1000
Randall Neighbors	Blackwell	580-762-6090		100
Dan Norman	Creek	918-367-3255		100
Kevin Ormand	Kay	580-362-3252		80
Lenert Pfeiler	Adair	918-696-6232		100
Garland Phillips	Wagoner/Cherokee	918-456-8924		100
Chris Piazza	Delaware	918-868-2389		100
Jerrel Powell	Muskogee	918-474-3783		150
B.D. Price	Lincoln	405-567-3564		
Don Pulley	Creek	918-247-6435		100

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Name	County	Phone	Email	Amount Needed
Brad Purdy	Tonkawa	580-628-2385		100
Richard Rambo	Holdenville	405-379-3841		100
Bobby Richison	Creek	918-367-5136		100
Levon Ropp	Ottawa	918-541-9122		100
Greg Roquet	Craig	918-782-2232		2000
Ross Farm	Muskogee	918-464-2212		2000
Norma Rosson	Rogers	918-272-7658		1
Dr. Pauline Sanders	Cherokee	918-456-1489		200
wayne schneider	Mayes	918-785-4562		5000
Eli Schrock	Coal	580-428-3529		200

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Name	County	Phone	Email	Amount Needed
Tony and Jeanine Sexton	Pittsburg	918-469-2215		100
Wayne Sexton	Kiowa	918-432-5387		100
Stan Sheffield	Muskogee	918-489-5590		2000
David Sheffield	Muskogee	918-478-4155		1000
Dick Sheffield	Muskogee	918-478-2713		40
Lyndle Shelby	Grady	641-342-7013		500
Shawn Sisco	Pittsburg	918-429-7881		800
Carl Sparks	Wilburton	0--		100
H.L. Staples	Lincoln	405-964-2811		100
Bud Steffen	Okfuskee	405-751-7131		1000

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Name	County	Phone	Email	Amount Needed
Don Stephens	Creek	918-428-1138		100
Harold Stephens	Atoka	580-889-7866		100
Ron Stoll	Delaware	918-868-2236		2000
Carl Tarver	Payne	918-225-3577		100
Mike Thompson	Atoka	580-889-3126		900
Raymond Tinney	McIntosh	918-473-6722		100
Tony Tracy	Roger Mills	580-497-2794		100
Mike Traylor	washington	479-846-3870		10000
Marvin Wageman	Pittsburg	918-389-4310		100
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Name	County	Phone	Email	Amount Needed
Marvin Wageman	Pittsburg	918-389-4310		400
Dennis Walker	Muskogee	901-682-2650		50
BILL WALLACE	OKFUSKEE	918-758-9623		20
James C. Walter	Hughes	918-688-7597		100
Jeff Weaver	Delaware	918-253-4830		80
JOHN WEAVER	MAYES	918-825-5805		150
JOHN WEAVER	MAYES	918-825-5805		150
John Weaver	Mayes	918-825-5805		100
Mark Whitfield	Payne	580-669-2279		200
Norbert Wick	Payne	918-459-3716		100

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Name	County	Phone	Email	Amount Needed
Norbert Wick	Payne	918-459-3716		100
mickey williamson	seminole	405-567-4959		200
mickey williamson	seminole	405-567-4959		100
Jacob Worley	Muskogee	918-682-4384		70
Devon Yoder	Wagoner	918-485-8248		100

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The Society for engineering in agricultural, food, and biological systems

This is not a peer-reviewed article.

Paper Number: 032149
An ASAE Meeting Presentation

Bacteria Release and Transport from Livestock Manure Applied to Pastureland

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Written for presentation at the
2003 ASAE Annual International Meeting
Sponsored by ASAE
Riviera Hotel and Convention Center
Las Vegas, Nevada, USA
27- 30 July 2003

Abstract. *A comparative field investigation was conducted on release and transport of bacteria from plots treated with cowpies, turkey litter, and liquid dairy manure. Rainfall conditions were simulated and runoff samples were collected to determine concentrations of E. coli, FC, and enterococcus present in runoff. The turkey treatment had the highest percentage of source bacteria released by rainfall, ranging from 1.3% for enterococcus to 14.5% for FC. The cowpie follows with percentages ranging from 0.3 to 0.6%. Runoff samples collected from the transport plots treated with cowpies averaged 137,000 cfu/100 ml for E. coli and over 165,000 cfu/100 ml for FC during two rainfall simulations. Bacteria concentration in runoff from plots treated with liquid dairy manure decreased between the two simulations, while the bacteria concentration from the plots treated with turkey litter increased. The percent of the bacteria that is initially released by rainfall that is transported to the edge of the field in overland flow was highest for the cowpie treatment (95 to 121%), followed by the turkey (41 to 138 %) and liquid dairy treatments (32 to 86%). Results indicated that among the animal waste types investigated, cowpies have the greatest potential to contributed E. coli, FC, and enterococcus to streams and waterways.*

Keywords. Fecal Bacteria, Agricultural waste, Nonpoint pollution, Land Application, Bacteria Release and Transport

Exhibit

"11"

Introduction

The transport of fecal bacteria from point and nonpoint sources to surface waters is becoming an increasing concern in the U.S. Elevated concentrations of fecal bacteria in drinking water can be detrimental to human health; potential diseases include Salmonellosis, Anthrax, Tuberculosis, Brucellosis, and Listeriosis (Azevedo and Stout, 1974). Approximately eight percent of U.S. river miles are impaired by pathogens (USEPA, 1998). A major source of fecal bacteria is runoff from agricultural land where manure has been applied or where animals are allowed to graze. Therefore, an understanding of the overland transport mechanisms for fecal bacteria can have a crucial role on the development of best management practices for reduction of pathogens concentration to surface water bodies.

The transport of bacteria in overland flow is affected by rainfall duration and intensity, method of manure application, fecal deposit age, and adsorption of cells to soil particles. Pathogenic organisms are largely retained at or near the soil surface (Faust, 1982), thus increasing the potential for pollution of surface runoff water. Because manure is less dense than soil, incorporating manure into soil increases the soil's interrill erodibility and thus the amount of bacteria detached by overland flow (Khaleel et al., 1979). Runoff from snowmelt or rainfall can carry bacteria from fresh manure into the stream. Doran and Linn (1979) found that runoff from a grazed pasture had fecal coliform (FC) concentrations 5-10 times higher than from an ungrazed pasture, but the FC counts in runoff from both the grazed and ungrazed pastures exceeded the water quality standard of 200 CFU/100 ml more than 90% of the time.

Thelin and Gifford (1983) placed cowpies on a platform and rained on them to determine the release of FC. Fecal deposits 5 days old or less released FC concentrations into the water on the order of millions of organisms per 100 ml. Fecal deposits that had not been rained on for up to 30 days released FC concentrations on the order of 40,000 per 100 ml. Larsen et al. (1994) placed bovine feces at 0.0, 0.61, 1.37, and 2.13 m from a runoff collection point to evaluate the release of FC. At the 0.0 m distance from the fecal deposit, the runoff bacteria concentrations corresponded to a release of 17% of the total FC in the manure, or between 40×10^6 and 115×10^6 organisms/ml. These values were significantly higher than those measured at the 2.13 m distance from the fecal deposit, where less than 5% of the organisms applied to the plots were present in runoff.

Computer simulation modeling is the primary approach used to develop Total Maximum Daily Loads (TMDL), even though insufficient data exist on several model input parameters related to the release and transport of fecal bacteria in runoff. Previous studies often focused on a single manure source and did not provide comparative results from different sources under similar climatic conditions. In addition, the detachment or release of fecal bacteria from land applied sources is not well-documented. Improvements in understanding the overland processes will improve modeling of fecal bacteria transport, and provide a basis for a more realistic evaluation of management practice implementation.

The overall goal of this study was to quantify the release and transport potential of three fecal bacteria indicators, *E. coli*, enterococcus, and fecal coliform (FC), from land applied manure during runoff events. The specific objectives of this study were to identify differences in bacteria transport among various livestock manures by comparing edge of field bacteria levels in runoff from pasturelands treated with liquid dairy manure, poultry litter, and cowpies. In addition, this study evaluated bacteria release rates for different types of manure applied to pasturelands with different history of previous manure applications. The data from this study will serve as a baseline from which the release and transport of fecal bacteria from agricultural watersheds to surface waters can be modeled.

Methodology

Field plots were constructed on existing pastureland in and around Blacksburg, VA. Two sets of plots were established; one set for the study of in-field bacteria release and one set for the study of bacteria transport. Release plots were used to measure available fecal bacteria concentrations in runoff. Four manure treatments (turkey litter, liquid dairy manure, cowpies, and none) and three land type treatments: pasture with a history of poultry litter application (Turkey Farm), liquid dairy manure application (Dairy Farm), and no manure application (Tech Research Farm) were studied. A total of 36 release plots were constructed for three replications of the four manure treatments and three land type treatments.

The transport plots were used to measure the concentrations of fecal bacteria present in overland flow at the edge of the field. The transport plots were only constructed at the Tech research farm due to the labor intensiveness of this component of the research. The release of bacteria from plots applied with liquid dairy, dried poultry litter, and standard cowpies were compared to control plots on which no animal waste was applied. A total of eight transport plots were constructed; two replications of each treatment (turkey litter, liquid dairy manure, cowpies, and control).

Plot Construction

Twelve release plots were constructed at each of the three sites for measurement of fecal bacteria concentrations available to runoff. Each release plot had the dimensions of 1 m by 1 m. Pre-fabricated steel borders were placed into the soil along the plot boundaries to prevent water movement into or out of the plots. Runoff drained through a small flume and was collected down-slope in a bucket. The runoff volume was determined by weighing the bucket.

Eight transport plots were constructed at the Tech research farm. Each transport plot was 3 m wide by 18.3 m long on an approximate 5.5 percent slope. Plywood borders were placed to a depth of 15 cm along the plot boundaries to prevent water movement into or out of the plots. A "V" shaped outlet was placed at the down slope end of each plot to direct runoff into a 0.15 m (6-inch) H-flume equipped with an FW-1 stage recorder for flow measurement. The FW-1 stage recorder recorded runoff depth continuously.

Animal Waste Collection and Application Methods

The state of Virginia requires phosphorous-based application of manure on crop and pasture lands. This method uses the residual phosphorous levels in the soil and the phosphorous levels in the manure to determine the manure application rate. The P_2O_5 application rates recommended for Orchardgrass/Fescue-Clover Pastures on soil productivity groups I and II (DCR 1995) were 90.7 kg/acre (81 lbs/acre) at the Tech farm and 0 kg/ha (0 lbs/acre) at the turkey and dairy farms, respectively.

Because the turkey and dairy farms have a history of receiving land applications of manure, the phosphorous levels were much higher in these fields. The Department of Conservation and Recreation (DCR) Standards and Criteria (1995) recommendation is that no additional phosphorous be applied to the pasture. Currently, the best solution is to apply the manure at a rate slightly lower than the estimated crop uptake, or to restrict manure applications to every other or every third year. Based on this approach, the experimental design was adjusted so that the manure would be applied to the plots at the rate of 56 kg P_2O_5 per hectare (50 lbs P_2O_5 per acre). Farm equipment used to spread manure cannot spread evenly or accurately if the application rates are too low.

Previous animal waste analysis reports were obtained from the DCR and from the farm managers. The previous analyses were used to estimate the phosphorous content in the dairy and turkey manure that would be applied to the plots. Based on the previous year's manure samples, the waste was applied to the plots at a rate of 56 kg P_2O_5 per hectare (50 lbs P_2O_5 per acre). Table 1 compares the results from the previous manure tests to those for the manure samples collected prior to their application to the plots.

Table 1. Concentrations of P_2O_5 in manure and the application rate and volume of the manure applied to the transport and release plots.

Manure type	P_2O_5 estimate based on samples from previous years	P_2O_5 estimate based on current waste samples	P_2O_5 applied to the plots	Application Rate	Transport Plots	Release Plots
Liquid Dairy	0.67 kg/1000 L	0.67 kg/1000 L	56 kg/ha	81,958.5 L/ha	450.1 L/plot	8.2 L/plot
Cowpie	2.0 kg/t	1.7 kg/t	50 kg/ha	29.4 t/ha	161.6 kg/plot (180 cowpies)	3.0 kg/plot (3 cowpies)
Turkey	20.4 kg/t	19.9 kg/t	54.7 kg/ha	2.8 t/ha	15.1 kg/plot	0.28 kg/plot

The dried turkey litter was collected from the Virginia Tech turkey barns. The litter, comprised of pine shavings and manure, was collected after a flock of turkeys were sent to market. The litter was stacked under a covered shed for a time period varying between 3 and 6 weeks before it was applied to the plots. The litter was uniformly broadcast onto the plots using small buckets.

The liquid dairy manure applied to the plots was obtained from the Virginia Tech Dairy manure storage pond. The storage pond contents are agitated twice a year, to suspend the solids that accumulate on the bottom of the pond. The manure was pumped into a tank and stored throughout the duration of the field experiment. The liquid manure was mixed in the tank before being drained into buckets and applied to the field plots.

"Standard" cowpies were constructed from fresh dairy cow deposits. Each cowpie was standardized by weight and shape, and randomly positioned by project personnel at various locations in the "cowpie" treatment plots. The size and shape of the "standard cowpies" was based on research by Thelin and Gifford (1983), who developed standard cowpies to study FC release patterns. The fresh deposits were formed by taking fresh manure and mixing it in a cement mixer for approximately 15 minutes. The manure was then placed in a mold with a diameter of 20.3 cm and a depth of 2.54 cm. Fecal deposits were placed in the mold until a weight of 0.9 kg was reached. The transport plots were divided into 1 m by 3 m sections. Approximately 9 cowpies were placed in each of the sections. A total of 360 cowpies were applied to the two transport plots. The three cowpies were randomly placed in each of the 1 m by 1 m release plots.

Rainfall simulation on Release Plots

A Tlaloc 3000 portable rainfall simulator, based on the design of Miller (1987), with a ½ 50WSQ Tee Jet nozzle was used to apply rain to the release plots. Rainfall simulations were conducted within 24 hours of the manure application. The plot was rained on until runoff occurred for 30 minutes. After 30 minutes, the rainfall simulation ended and the runoff sample was collected.

This rainfall simulator has been developed as the standard simulator used to test the phosphorous index in various states.

Rainfall simulation on Transport Plots

Due to the unreliability of natural precipitation for short-term field research, the Department of Biological Systems Engineering's rainfall simulator (Dillaha et al., 1987) was used to generate storm events to produce runoff from the field plots. Rainfall was applied at a uniform rate (approximately 4.45 cm/hour) to all pasture plots. A series of rainfall simulations was conducted within 24 hours after manure application. The first simulation (S1) lasted approximately 3 hours. The rainfall continued until a steady state runoff resulted. The S1 simulation represented the bacteria transport during dry field conditions. Before the second simulation (S2) began (approximately 22 hours after the end of the first simulation, S1), soils were saturated. This was due to an overnight natural rainfall of approximately 2.9 cm (1.15 in) and the long simulated rainfall event during the first simulation. Therefore, the second rainfall simulation represented the transport characteristics of bacteria under saturated soil conditions.

The uniformity of rainfall applications was measured using a network of volumetric rain gauges in and around each plot. The uniformity coefficient was determined for both rainfall simulations. The uniformity coefficients for the first and second rainfall events were 93% and 95.5%, respectively

Sampling and Analysis

The total runoff volume was collected from each of the release plots and weighed to determine the volume. The runoff was collected in buckets and a single sample was taken from the total runoff volume. A total of 32 runoff samples were collected from the release plots. Grab samples of runoff water were collected from the transport plots every 3 to 9 minutes during both simulated storm events. A total of 68 samples were collected during S1 and 68 samples were collected during S2.

Samples were analyzed, immediately after collection, for FC, *E. coli*, and enterococcus concentrations in runoff. The samples were analyzed using the Spread Plate (Clesceri et al., 1998) and membrane filtration methods (Clesceri et al., 1998 and EPA, 2000).

Statistical Analysis

The release plots were analyzed using a Generalized Randomized Block Design procedure. Tukey's pairwise comparison was used to test significance between the treatments at the P<0.05 significance level. Transport plots were analyzed using the repeated measure method (Ott and Longnecker, 2001). The response variable was the concentration of bacteria in the runoff leaving the plot. Tukey's pairwise comparison was used to find significance between the treatments at the P<0.05 significance level. The null hypothesis tested for both the release and transport plots was that there was no difference in the concentrations of the bacteria in surface runoff among the treatments.

$$\mu_{turkey} = \mu_{cowpie} = \mu_{liquid\ dairy} = \mu_{control}$$

Results and Discussion

Release Plots

The concentrations of bacteria and TSS in runoff from the release plots are presented in Table 2. The results from the Tech Research Farm are quite different than expected. The Tech Research Farm, which in the past had not received manure applications, had much higher concentrations in the runoff from the control plots compared with the other farms. This could be due to a higher wildlife population in the area and the lack of cattle to discourage wildlife, or to the build up of stable populations in the soil (Faust, 1982). The plots with the liquid dairy and turkey manure applications had lower concentrations of bacteria than the control. The cowpie plots, consistent with the other sites, had the highest concentrations of bacteria in the runoff. The turkey plots resulted in less suspended solids in the runoff than the control, which may partially explain the reason for reduced bacterial loading from these plots.

Table 2. Concentrations of enterococcus, fecal coliform, *E. coli,* and Total Suspended Solids from the release plots.

Tech Research Farm	**Enterococcus (cfu/100 ml)**	**Fecal Coliform (cfu/100 ml)**	***E. coli* (cfu/100 ml)**	**TSS* (mg/L)**
Liquid Dairy	17,000	35,000	23,000	86.0
Cowpie	285,000	159,500	152,500	71.5
Turkey	12,075	29,050	18,550	31.5
Control	23,000	29,350	21,300	37.5
Dairy Farm	**Enterococcus (cfu/100 ml)**	**Fecal Coliform (cfu/100 ml)**	***E. coli* (cfu/100 ml)**	**TSS (mg/L)**
Liquid Dairy	3,067	300,000	55,000	166.0
Cowpie	8,133	300,000	300,000	189.3
Turkey	1,880	92,000	28,000	134.7
Control	1	134	1	1.0
Turkey Farm	**Enterococcus (cfu/100 ml)**	**Fecal Coliform (cfu/100 ml)**	***E. coli* (cfu/100 ml)**	**TSS (mg/L)**
Liquid Dairy	1,867	47,667	30,667	110.7
Cowpie	1,007	65,000	37,000	131.0
Turkey	507	9,000	4,733	146.7
Control	23	167	1	51.7

*Total Suspended Solids

The plots at the Turkey Farm and the Dairy Farm had more consistent results. Figure 1 compares the average concentrations of *E. coli* in the runoff at the three different farms. The plots treated with cowpies had the highest *E. coli* concentrations in the runoff. In general, the plots treated with liquid dairy manure had higher *E. coli* concentrations than the plots treated with turkey litter. Statistical analysis performed on the treatments, which accounted for the different site locations, found statistical differences among all treatments except for the turkey treatment, which was not statistically different from the liquid dairy or control treatments.

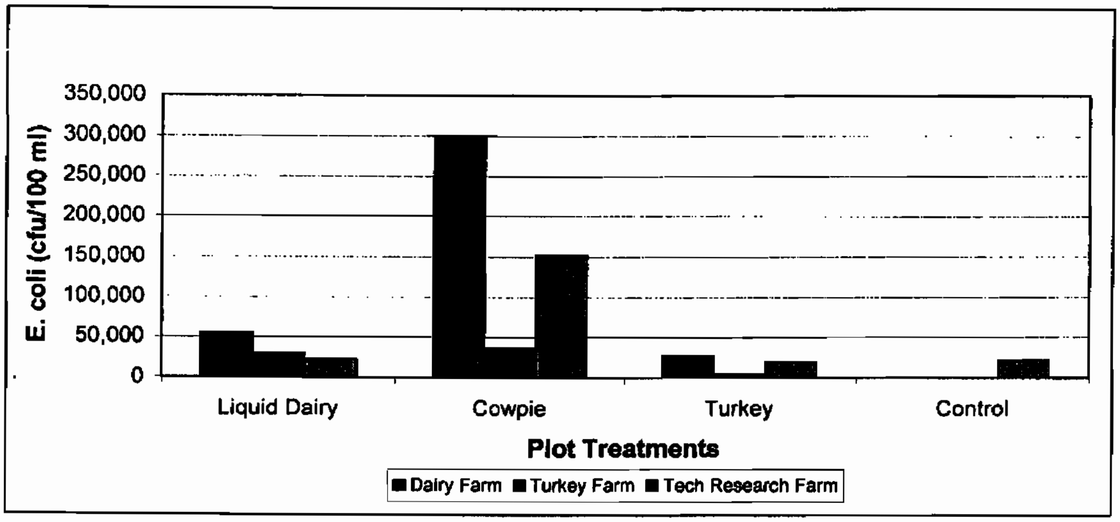

Figure 1. *E. coli* present in runoff from release plots

Figure 2 shows the concentration of FC in the runoff at the three different farms. The plots treated with cowpies, again, had higher FC concentrations in the runoff followed by the liquid dairy and turkey litter. Statistical analysis indicated significant differences among all treatments except for the turkey treatment, which was not statistically different from the control treatment. The FC release concentrations from the plots treated with cowpies ranged from 6.5×10^4 CFU/100 ml to 30×10^4 CFU/100 ml, which corresponds with the values reported in the study by Larsen et al. (1994) who reported the FC release concentrations from bovine feces were between 40×10^4 and 115×10^4 organisms/100 ml.

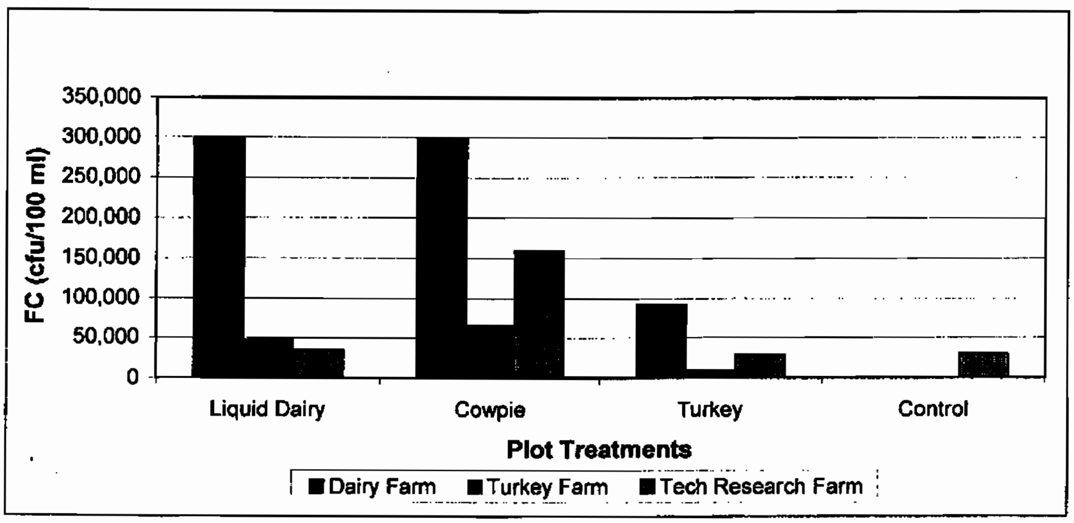

Figure 2. Fecal coliform present in runoff from release plots

In summary, the results from the release plots indicate that during a short but intense rainfall event, the cowpie treatment has the highest bacteria release rate. The liquid dairy treatment had a slightly lower release rate, followed by the turkey litter treatment.

By comparing the bacteria concentrations in the source manure to the average concentrations from the release plots, we were able to determine the percent of the source bacteria that is initially released by rainfall and would potentially be available to be transported to the edge of the field in overland flow. The bacteria concentration in the source manure is initially measured in CFU/gram. This was converted to CFU/100 ml to make the comparison. Table 3 shows the percent of bacteria released from the manure.

Table 3. Percent of bacteria that are released from the manure.

Manure Treatment	% Fecal Coliform released from waste	% *E. coli* released from waste	% Enterococcus released from waste
Liquid Dairy	0.3%	0.1%	0.0%
Cowpie	0.6%	0.5%	0.3%
Turkey	14.5%	5.7%	1.3%

The turkey treatment had the highest percentage of source bacteria released by rainfall, ranging from 1.3% for enterococcus to 14.5% for FC. The cowpie follows with percentages ranging from 0.3 to 0.6%.

Transport Plots

Runoff from the transport plots was measured continuously using FW-1 stage recorders. Figure 3 shows the runoff volume from each of the transport plots. Runoff volume increased during S2, due to the saturated ground conditions before the simulation began. The runoff from the plots varies due to differing soil conditions or compaction levels in the soil prior to the rainfall simulation. Runoff volumes also varied because the time at which runoff began differed among the plots. During S1, the plots treated with liquid dairy had the highest runoff volume, followed by the cowpie, turkey litter, and control treatments. During S2, the plots treated with cowpies had the highest runoff volume, followed by the control, liquid dairy, and turkey litter treatments. The predominant factor affecting runoff volume appears to be the time of between the beginning of the rainfall simulation and when runoff first occurred. The plots with earlier runoff times also had higher runoff volumes.

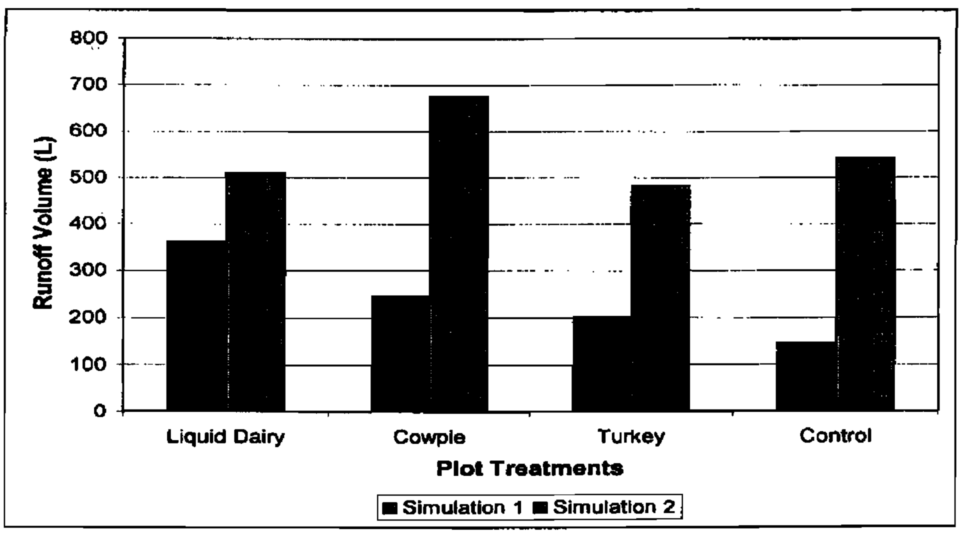

Figure 3. Runoff Volumes from the transport plots.

Statistical analysis was performed on the runoff volumes using the repeated measure method and Tukey's pairwise comparison. No statistical differences in the runoff volumes from the different treatments were found. There were also no significant differences between the runoff volumes during S1 and S2 simulations at the 0.05 error level.

The flow-weighted concentration (FWC) was calculated for the total suspended solids (TSS) in runoff from each of the transport plots (Table 4). The FWC was calculated by multiplying the sample concentration by the volume of runoff that occurred during that time period. These values were then summed and divided by the total volume of runoff from the plot. The addition of the manure to the plots decreased TSS concentrations from the liquid dairy and turkey plots when compared to the control. Gerba et al. (1975) reported that as bacteria and organic substances accumulate on the soil surface, the trapped bacteria become part of the filtration system, and increase the filtration properties of the soil. This may explain the decrease in TSS concentrations from the liquid dairy and turkey litter plots during the first simulation. The cowpie treatment covered just the areas where the fecal deposits were located, but not the entire plot area. The cowpies had higher moisture content than the other waste types, therefore it is possible that after the raindrop impacts disintegrated the cowpies, they were more readily carried off the plots by runoff.

Table 4. Total Suspended Solid concentrations present in runoff from the transport plots.

Treatment	Total Suspended Solids – FWC*		
	Simulation 1 (mg/L)	Simulation 2 (mg/L)	Average (mg/L)
Liquid Dairy	59.9	83.4	71.7
Cowpie	176.7	54.6	115.7
Turkey	37.3	22.5	29.9
Control	85.2	29.1	57.1

*Flow Weighted Concentration

The trends in the TSS concentrations were compared to the trends for the bacteria concentrations in the runoff from the transport plots (Table 5). In general, the plots treated with cowpies and liquid dairy manure had lower bacteria concentrations in the runoff during S2 than S1. The opposite occurred for the turkey litter, except for the enterococcus concentrations. The TSS concentrations, however, decreased during S2 simulations compared with S1 for the cowpies and turkey litter treatments (Table 4), but they increased for the plots treated with liquid dairy manure. These results indicate that higher TSS concentrations in runoff do not necessarily correspond with higher bacteria concentrations. The proportions of bacteria transported in the dissolved form and attached to suspended solids may differ among the different treatments.

Runoff data and sample concentrations from the transport plots were used to calculate the bacteria flow weighted concentrations. Table 5 presents the bacteria FWC for the transport plots for both S1 and S2 simulations.

Enterococcus concentrations in runoff were slightly lower than the *E. coli* and FC concentrations for all treatments. Enterococci are a subgroup of fecal streptococcus. Enterococcus is used as an indicator bacteria because it is often present in recreational water bodies when human illness occurs (USDA, 2000) and is most often used as a fecal indicator in marine waters. Federal standards for primary contact enterococcus is 33 CFU/100 ml. The concentrations reported in this study are much greater since they represent the edge of the field levels as opposed to in-stream concentrations. In-stream concentrations are expected to be lower due to dilution effects and die-off. The cowpie treatment had the highest FWC for both S1 and S2 events. The enterococcus levels in the runoff from the liquid dairy and turkey plots were slightly lower during

S2 compared with S1. Statistical analysis was performed using the repeated measure method and Tukey's pairwise comparison. No statistical differences in the enterococcus concentrations in the runoff from the different treatments were found. There were also no significant differences between the concentrations measured during S1 and S2 simulations at the 0.05 error level.

Table 5. Flow weighted bacteria concentrations in runoff from the transport plots for rainfall simulations S1 and S2.

Treatment	Enterococcus (cfu/100 ml)			FC* (cfu/100 ml)			*E. coli* (cfu/100 ml)		
	S1†	S2‡	Average	S1	S2	Average	S1	S2	Average
Liquid Dairy	9,341	3,179	6,260	74,073	6,817	40,445	31,294	5,526	18,410
Cowpie	187,406	50,465	118,936	234,288	96,045	165,166	200,047	73,235	136,641
Turkey	6,757	6,521	6,639	16,719	18,953	17,836	9,275	16,450	12,863
Control	6	2	4	51	36	43	16	11	13

*Fecal coliforms; †Simulation 1; ‡Simulation 2

Figure 4 presents the *E. coli* results in a graphical form. The *E. coli* FWC decreased for the liquid dairy and cowpie treatments during S2, compared with the S1 values. For the turkey treatment, however, the E-coli concentrations increased during S2. This increase can be partly due to the nature of the poultry waste. The liquid dairy and cowpies wastes are more easily transported, while the turkey litter is dry and may require a more significant runoff event to transport the litter off of the plots. The runoff from the cowpie plots clearly had the highest E-coli FWC for both simulations. Statistical differences were only found between the *E. coli* concentrations in the runoff from the cowpie and the control plots. There were no statistical differences in *E. coli* concentrations between the two rainfall events.

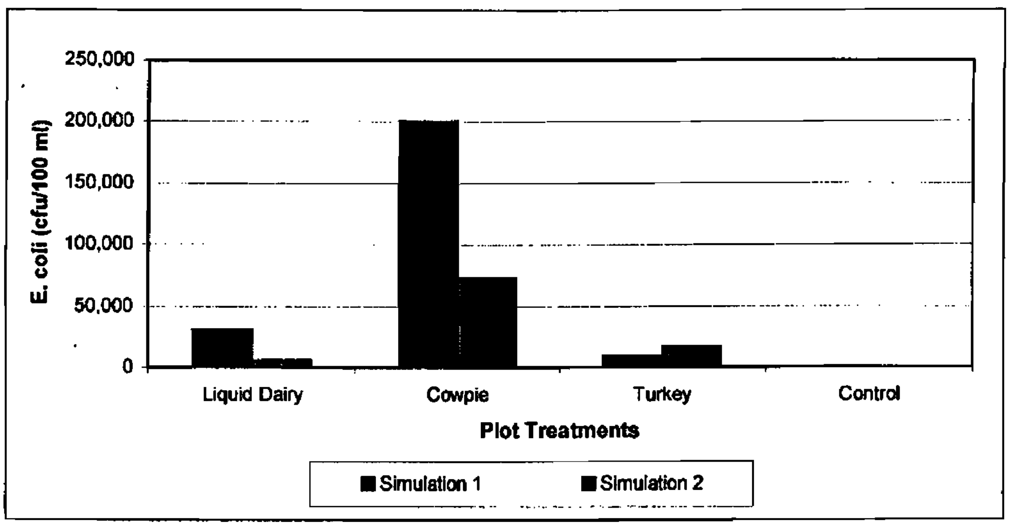

Figure 4. Flow weighted concentrations of *E. coli* in runoff samples from transport plots.

The concentrations of FC in runoff exhibited similar patterns as the E-coli among the different treatments. During S1, the liquid dairy and cowpie treatments had the highest average FC FWC. During S2, the cowpie continued to produce the highest FWC of FC, but the runoff from the plots treated with turkey litter had the second highest FWC, followed by the liquid dairy. The runoff FWC of FC from cowpie treatment were statistically different from all of the other treatments. There were no statistical differences in FC FWC for each treatment between the two rainfall simulations.

Federal standards for primary contact for FC is 200 CFU/100 ml, much less than the levels present in runoff from the manure treated plots. Baxter-Potter and Gilliland (1988) reported that the typical range of FC present in runoff from pastureland were 1,000 to 57,000 CFU/100 ml. The average value for the two simulations from the pasture treated with cowpies in this study was 1.65×10^5 CFU/100 ml. The cattle stocking density is not provided in the previous studies, therefore it is not possible to compare the results. Furthermore, this study was designed to evaluate bacteria losses from edge of the field in small plots under intensive rainfall conditions. The bacteria concentrations reported in this study are expected to be much higher than those produced under natural rainfall from large pasture fields or watersheds. FC concentrations from grazed pasture in south central Nebraska contained concentrations of 1.21×10^5 CFU/100 ml (Schepers and Doran, 1980), which is similar to the results obtained from this study. Fecal bacteria concentration in runoff from grazed pasture is dependent on both the stocking density and the proximity of the cattle to streams. Cattle loafing in shaded or feeding areas produce high concentrations of cowpies in a smaller area and therefore higher bacteria concentrations in runoff. McCaskey et al. (1971) found FC concentrations to range from 1.4 to 21.7×10^6 CFU/100 ml in runoff from dairy waste applied to pasture plots by a tank wagon. They also reported that runoff from the control area had FC concentrations of 9.9×10^5 CFU/100ml. These values are much greater than the concentrations of 4.0×10^4 CFU/100 ml measured in our study.

To determine a relationship between the bacteria release and transport, the average concentrations from the release plots were compared to the average FWC from the transport plots. By comparing the concentrations from the release plots to the concentrations from the transport plots, we were able to determine the percent of the bacteria initially released by rainfall that is transported to the edge of the field in overland flow. Table 6 shows the percent of the released bacteria that is transported in overland flow.

Table 6. Percent of released bacteria that are present in overland flow.

Manure Treatment	% Released fecal coliform present in overland flow	% Released *E. coli* present in overland flow	% Released enterococcus present in overland flow
Liquid Dairy	31.7%	50.8%	85.6%
Cowpie	94.5%	83.7%	121.3%
Turkey	41.1%	75.2%	137.7%
Control	0.4%	0.2%	0.1%

The cowpie treatment had the highest percentage of released bacteria present in overland flow with percentages ranging from 95 % for FC to 121% for enterococcus. The turkey treatment follows with percentages ranging from 41% to 138%. The differences between the three species are related to the survival characteristics of the bacteria. Enterococcus is able to survive longer in the environment than FC and *E. coli*. The transport concentrations may be higher than the release concentrations because of background bacteria present in the soil.

In recent years significant changes have occurred in the livestock industry. Animal production areas are highly concentrated, resulting in more manure applications to the fields. In addition, the indicator organisms have changed over the years. Many previous studies provided information on total coliforms, fecal streptococcus, and FC concentrations in runoff. The State of Virginia is currently using *E. coli* as the primary indicator organism in fresh water and enterococcus as the primary indicator organism in marine waters (Virginia DEQ, 2002).

Previous studies rarely provide information on *E. coli* or enterococcus. Runoff from the transport plots treated with manure greatly exceeds the Federal Standards for primary contact.

Summary and Conclusions

Field plots were constructed on existing pastureland in southwest Virginia. Two sets of plots were established; one set for the study of in-field bacteria release and another set for the study of bacteria transport. The plots were treated with turkey litter, liquid dairy manure, and standard cowpies. Rainfall was simulated and runoff samples were collected to determine concentrations of *E. coli*, FC, and enterococcus present in runoff.

The runoff collected from the release plot treated with cowpies had higher concentrations of fecal bacteria indicators than those treated with liquid dairy manure or turkey litter. The turkey treatment had the highest percentage of source bacteria released by rainfall, ranging from 1.3% for Enterococcus to 14.5% for FC. The cowpie follows with percentages ranging from 0.3 to 0.6%.

The bacteria flow weighted concentrations in runoff samples from the plots treated with cowpies were over 200,000 CFU/100 ml of *E. coli* and almost 235,000 CFU/100 ml of FC. Runoff from plots treated with liquid dairy treatment had greater fecal bacteria concentrations in runoff during the first rainfall event (S1), which was applied within 24 hours after manure application. These concentrations however were reduced during the second rainfall event (S2), which occurred one day after the initial rainfall. During S1, the concentrations were 31,000 CFU/100 ml for *E. coli* and 74,000 CFU/100 ml for FC, but they decreased to much lower levels during S2 (5,500 CFU/100 ml for *E. coli* and 6,800 *CFU*/100 ml for FC). The turkey treatment resulted in the opposite effect. During S1, the bacteria concentrations remained low (9,300 CFU/100 ml for *E. coli* and 17,000 CFU/100 ml for FC, but increased during S2 (17,000 CFU/100 ml for *E. coli* and 19,000 CFU/100 ml for FC). This is most likely explained by the composition and transport characteristics of the waste. The percent of the bacteria that is initially released by rainfall that is transported to the edge of the field in overland flow was highest for the cowpie treatment (95 to 121%), followed by the turkey (41 to 138 %) and liquid dairy treatments (32 to 86%).

This comparative study clearly indicates that the cowpies have a greater potential to contribute fecal bacteria into streams than the land application of liquid dairy manure or turkey litter; although, runoff from all treatments exceed federal standards for primary contact. These results imply that areas where cattle may congregate, such as in watering or feeding areas, should be moved away from streams, and the buffer zone between grazing cattle and streams should be increased to reduce the loading of fecal bacteria.

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